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Volume 2. TES Report Appendices

# FUTURE GENERATION TACTICAL ENGAGEMENT SIMULATION

# U.S. ARMY PRIORITIZED NEEDS AND RECOMMENDED SUPPORTING TECHNOLOGY DEVELOPMENT

AUGUST 1988

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Prepared for
**Department of the Army**
**Project Manager, Training Devices**

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Through an agreement with
**National Aeronautics and Space Administration**
by

**Jet Propulsion Laboratory**
California Institute of Technology
Pasadena, California

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# FUTURE GENERATION TACTICAL ENGAGEMENT SIMULATION

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**AUGUST 1988**

APPROVED BY:

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Prepared for
**Department of the Army**
**Project Manager, Training Devices**

Through an agreement with
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by



**Jet Propulsion Laboratory**
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Pasadena, California



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# PREFACE

This report is structured in the following manner. The full report consists of two volumes. Volume 1 contains the main body of the report. Section 1 provides an overview of the TES study and report. A summary of the JPL recommendations to the Army, the final results of the study, is presented as Section 2. Sections 3 and 4 give overviews of the methodology used to implement the study leading to these recommendations. Section 5 is a detailed discussion of the TES technology development programs recommended by JPL.

This is Volume 2 of the report. This volume contains all of the appendices, which provide detailed material on the methodology used in the study, the complete results of the Army responses on future generation TES needs and their priorities, and additional discussions on TES technology. The material in the appendices serves to support the conclusions and recommendations reached by JPL, and also provides a comprehensive and valuable database for any follow-on studies and development in future generation TES.

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This report describes the results of a study to determine the U.S. Army prioritized needs for future generation tactical engagement simulation (TES) systems for the years 1995-2015. It also assesses the availability of technologies to meet the highest priority needs and describes and recommends technology development programs to ensure that the necessary technologies will be available when needed.

This report was prepared by the Jet Propulsion Laboratory for the U.S. Army Project Manager for Training Devices (PM TRADE) as part of the Simulation of Area Weapons Effects (SAWE) Project.

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## ACRONYMS

| | |
|---|---|
| AAR | After Action Review |
| AMC | Army Materiel Command |
| BTA | Best Technological Approach |
| CW | Chemical Warfare |
| GPS | Global Positioning System |
| JPL | Jet Propulsion Laboratory |
| MILES | Multiple Integrated Laser Engagement System |
| NTC | National Training Center |
| PM TRADE | Project Manager for Training Devices |
| PNS | Prioritized Needs Summary |
| SAG | Study Advisory Group |
| SAWE | Simulation of Area Weapons Effects |
| TES | Tactical Engagement Simulation |
| VLSI | Very Large Scale Integrated |

# APPENDIX A

## JPL VISITS TO ARMY ORGANIZATIONS


| | | |
|---|---|---|
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## SECTION 1

## SUMMARY

Implementing the approach to the study already described, JPL drafted a survey agenda for discussing future generation TES needs with Army commands. JPL first used this agenda at meetings with III Corps and TCATA personnel at Ft. Hood in March 1986. At the next SAG meeting (March 25, 1986), JPL reported the results of the first meetings and received SAG approval to proceed with visits to Army commands in both Europe and CONUS. The itinerary for these meetings, and the necessary arrangements to meet with the appropriate units, were handled by 7th Army Training Command, USAREUR; CAC; and HQ FORSCOM. Table 1, at the end of this section, shows a list of the Army commands visited by JPL.

Prior to meeting with USAREUR personnel in Germany, JPL conducted precursor visits to Ft. Hood to both test the effectiveness of the proposed review process and material and gather comments on future generation TES needs from Ft. Hood personnel. JPL first met with experienced test instrumentation personnel at TCATA, Ft. Hood. Comments at this meeting dealt mainly with hardware and hardware problems for engagement systems and related instrumentation. It should be noted that the role of TCATA is testing, not training. However, TCATA personnel have considerable experience with TES systems that is very applicable to training requirements. Troops or units that participate in TCATA tests are usually receiving field training during the force-on-force exercises with MILES or TCATA simulation devices; thus TES has a dual role at Fort Hood. JPL would expect the same TES test and training interactions to occur with TES with the 4th Infantry Division and CDEC at Ft. Ord or Ft. Hunter-Liggett, or for the 9th Infantry Division and ADEA at Fort Lewis.

A meeting was also held at Ft. Hood with III Corps Training Section personnel. Comments were particularly applicable to the problems of force-on-force field training exercises at the home station. Experience with TES at the NTC was the main subject of discussion at a third meeting, with the commander and executive officer of the 2nd of the 7th Cavalry, 1st Cavalry Division. (This unit and individuals had the experience of several rotations at the NTC by being attached as the cavalry unit for several other battalions; additionally they were the first to use the Bradley with TOW and the chain gun at NTC.) Complete reports of these meetings are included in the attached trip reports (Section 2 of this appendix).

JPL reviewed the results of these meetings with TES personnel at ATSC, Ft. Eustis, before departing for Germany. Additional guidance was given for conducting the TES interviews and discussions, and on the types of questions to ask.

Also, prior to going to Germany, a visit was made to interview COL Larry Word, at that time the TRADOC Systems Manager for JRTC. The comments by COL Word, which can be found in the trip report, were particularly valuable because of his considerable experience with MILES and his field experience at the Army's National Training Center at Ft. Irwin.

Nine meetings were held at five Army commands in Germany as arranged by the SAG representative from the 7th Army Training Command Headquarters in Grafenwoehr. These commands were selected by the TES SAG to provide a wide representation of the several different heavy mechanized combat units stationed in Germany that use TES. Comments were mainly from combat personnel, responsible for unit field training and who used MILES devices, on their experiences with MILES in small-scale exercises at Local Training Areas (LTAs) or Maneuver Rights Areas (MRAs). Many significant inputs were obtained on the needs for TES, especially for training with smaller units in confined training areas. Complete reports of these meetings are found in the trip reports (Section 2).

Twenty-nine meetings were then held at sixteen Army commands in CONUS, following an itinerary developed by FORSCOM Headquarters and CACTA, Ft. Leavenworth. The comments received in these meetings added to the consensus of those received in Germany. Personnel interviewed in CONUS also included Reserves and National Guard. Trip reports for each of these meetings are included in Section 2.

JPL recommends that developers of future TES systems review the extensive amount of material in the trip reports. They are a valuable data base of Army experience with TES.

In addition to comments related to needs for future generation TES, JPL received considerable input on the current use of MILES. These were not the isolated remarks of a few individuals; they were universal enough to be considered a consensus. The relevance of this information to this report is that it represents some of the reasons why the present generation TES (MILES) is not being used to its full potential. This is a problem that will not be solved solely by the application of new technology. These comments on current experience with MILES are included as Section 3.

JPL also met with top management and engineering personnel from each of the leading suppliers of TES systems. The purpose of these meetings was to acquire insight into the current use of TES from the manufacturer's viewpoint, to assess the level of performance of today's TES systems, and to discuss the technologies that were under development for future generation TES systems by these suppliers. Trip reports for these meetings are also included in Section 2.

Tables 1 and 2, respectively, list the meetings with Army commands and TES suppliers.

Table 1. TES Meetings with Army Commands

| | |
|---|---|
| Mar 18, 1986 | TCATA, Ft. Hood, TX |
| Mar 18 | III Corps Training Command, Ft. Hood, TX |
| Mar 19 | 2nd of 7th, 1st Cavalry Division, Ft. Hood, TX |
| Mar 26 | TSM-JRTC, Ft. Monroe, VA |
| Apr 11 | ATSC, Ft. Eustis, VA |
| Apr 15 | 11th Armored Cavalry Regiment, Fulda, Germany |
| Apr 17 | 52nd Mechanized Infantry, 1st Armored Div., Bamberg, Germany |
| Apr 18 | 6th of 14th FA, 1st Armored Div., Katterbach, Germany |
| Apr 21 | Berlin Brigade, West Berlin, Germany |
| Apr 22 | 7th Army Training Command, Grafenwoehr, Germany |
| May 6 | NTC OPFOR, Ft. Irwin, CA |
| May 7 | 9th Infantry Divison, Ft. Lewis, WA |
| May 8 | CDEC, Ft. Lewis, WA |
| May 9 | CDEC, Ft. Ord and Ft. Hunter-Liggett, CA |
| May 13 | Air Defense Artillery School, Ft. Bliss, TX |
| May 14 | Combined Arms Center, Ft. Leavenworth, KS |
| May 15 | Field Artillery School, Ft. Sill, OK |
| May 16 | 4th Infantry Division, Ft. Carson, CO |
| May 20 | 101st Airborne Division, Ft. Campbell, KY |
| May 21 | Armor Center, Ft. Knox, KY |
| May 22 | Aviation School, Ft. Rucker, AL |
| May 29 | Special Forces School, Ft. Bragg, NC |
| May 29 | 82nd Airborne Division, Ft. Bragg, NC |
| May 30 | ARI, Ft. Benning, GA |
| May 30 | Infantry School, Ft. Benning, GA |
| Aug 5 | Combined Arms Training Activity, Ft. Leavenworth, KS |

Table 2. Meetings with TES Suppliers

| | |
|---|---|
| Aug 28, 1986 | Fairchild Weston Systems, Syosset, NY (AGES II) |
| Sep 11 | Loral Electro-Optical Systems, Pasadena, CA (MILES) |
| Oct 3 | Solartron Defence Systems, Middlesex, England (Simfire) |
| Oct 6 | Marconi Command & Control Sys., Surrey, England (MARTAC) |
| Oct 13 | SAAB Training Systems, Huskvarna, Sweden (BT-41) |
| Oct 15 | Kurt Eichweber, Hamburg, Germany (TALISSI) |
| Oct 17 | Giravions Dorand Industries, Suresnes, France (DX175) |

APPENDIX A

SECTION 2

TRIP REPORTS

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-085-86
July 10, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at TCATA, Ft. Hood, Texas
March 18, 1986

| | |
|---|---|
| COL John Theologos | Mr. Wayland Smith |
| CPT Rex Ploederer | Mr. James Geddie |
| Dr. Darrell Collier | Mr. Ken Matthews |
| Mr. Floyd Ong | |

Comments:

TCATA now supports about 160-200 players, vehicles only; they can't do dismounted troops which is a problem.

ATWESS cartridges are too expensive ($5.30), Hoffman devices don't have enough rounds.

RTF Industries make fire simulators and hit simulators; uses 20-ga. shotgun shells, tailored for several different weapons. These are low cost -- ($ .25-.60).

Using one signature simulator for several different weapons may not be a problem.

There is a need for black smoke for hit signatures.

The importance of hit signatures for mines and artillery is in the warning to other players.

They have no consensus that more than one type of kill is necessary.

The lack of ability to use tactical rangefinders is a big problem; there is no surrogate for the non-eye-safe rangefinder.

The importance of including ranging, lead angle, etc. is the effect on the time line.

"Angle of engagement" for direct fire is needed. BRL works with about $\pm$ 30°, but $\pm$ 10° may be desirable.

Identification of the firing weapon must be added to the MILES code.

An output plug on the MILES receiver would be very desirable.

There is a need to be able to change $P_k$.

10-15 extra pounds is the maximum weight that can be tolerated by a dismounted soldier.

Future systems at CDEC and TCATA will use GPS for position location.
"Everyone wants player location to within ± 10 meters, but we have been unable to demonstrate that we need better than ± 100 meters."

For area weapons in combined arms exercises, suppression is the effect wanted.

For chemical exercises, simulants and a check on mask use are needed.

TCATA uses video to verify weapon pointing.

There is increasing interest in playing the threat properly, including the effects of threat weapons. Acceptable threat surrogates are needed. About 50% of the known threat capability is classified (probably secret).

There is often great training value to the troops participating in a test, such as is done by CDEC and TCATA.

Negative training is always an important consideration.

Cheating is becoming less of a problem. Doing something dumb because of lack of understanding is more of a problem.

"The U.S. Army doesn't have a lot of experience with mine warfare". There is a need to know if we're doing it right in our simulations.

Laser pairing rates appear to be too low. 70% of attacker rounds and 40% of defender rounds don't pair.

There is a need to be able to tell if a simulation system is working adequately once a test is underway.

Engagement simulation for air-to-air combat, as well as ground-to-air and air-to-ground, is being asked for more and more.

Hazeline builds E-TRAIN, a way of training with EW.

A problem with MILES is things that block laser beams that wouldn't block bullets (such as foliage).

Boresighting of lasers is a continuing concern.

Need compatibility between the training and the testing communities since troops are used for testing.

One cue is suitable for several guns; doesn't need to be identifiable with weapon, just reasonable.

Smoke is most important, then flash, last is bang. This may be due to the vehicle noise, etc.; dismounted may be different.

Need to have a training mode on all tactical equipment.

Use TES training system for many tasks: gunnery, force on force, etc.

New TES system should make every member of crew do everything he is supposed to do.

New TES system must be part of weapons platform. It is not taken off; TCATA spends one week for removal and installation. This will save dollars and make the system more resistant to failure.

MILES system is used about 30% of units total training time; 50% of field training time.

Data collection: need weapon ID, aspect angle, time/distance of arrival, player ID, weapon, TOW time.

Need smoke simulation.

Need to integrate the UCOFT, ARTBASS with TES in the field.

Need fault isolation so that TES can be fixed. Infantryman's set is not the problem; a weapons platform is.

MILES simulation rounds for a tank ammo load are inadequate; they need 60 rounds; reloading of Hoffman Device is not realistic.

TES signature system should be programmable for signature effect needed to match signature of gun fired at time. It may be possible to use one set for guns and use ATWES for TOW.

For kill, near miss, shell on steel, etc., a signature is needed but it is not clear what is adequate. Signature needed is different for different players--the gunner, the target, and people near to target. Candidate solutions and examples: colored smoke, burning cue 2 to 20 minutes. RTF Industries makes a black smoke burning system.

TES should train people to limit talk on radio by causing a penalty by being targeted if commo is too long.

TES/3:085

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-209-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the III Corps Training Section, Ft. Hood, Texas, March 18, 1986

| | |
|---|---|
| LTC Crayton | SGT Barnes |
| CPT McCraig | SGT Brown |

Comments:

Because of the time it takes to move MILES from one vehicle to another (practically, four days to install, three days to remove) more MILES is needed for each division to reduce the necessity to swap from company to company.

There is a need for "shoot back targetry", to punish crews that take too long on live fire ranges. This would probably require engagement simulation technology.

Gunnery simulation needs to reinforce good habits. Thus ranging, lead, superelevation, etc., need to be included.

TES tank systems should involve all four crewmembers in a tank; the loader is always left out which affects the time line for engagements. The tank crew must train as a team.

"Maneuver fire support integration" is not trained now.

There should be automatic reset so training can go on.

Indirect fire simulation may only be used when training at the battalion level, but receiving fire only should be available down to the platoon level.

Dismounted infantry exercises will probably be done only with a company or larger since Bradley platoons result in a small number of useable infantry.

Using a fixed 10-second hold-on time for the TOW simulation is unrealistic.

Commanders don't want to use MILES-TOW; they think it is more complex than the real weapon.

MILES-TOW won't stay boresighted.

Killing tanks with a sloppy lay of the MILES laser is negative training.

Having onboard TES in wartime would be useful; if there were lulls measured in weeks, units will be training.

BITE would be useful, especially for the systems on the M1 and the Bradley.

MILES teaches bad gunnery habits on tanks: no ranging, no superelevation, no manual lead, incorrect sight picture. It needs to be changed to reinforce correct training habits.

Incoming artillery should be a surprise; receiving it may not mean you're doing something wrong.

Dismounts are attrited by artillery using the MILES controller gun, but sometimes not until 30 minutes later.

There are approximately 240 days a year available for training; if each vehicle had its own TES, the TES would be in use on about 50% of the training days.

Now, sharing MILES in a two week training cycle, one week is used up putting MILES on the vehicles and taking it off. The MILES Bradley is worse.

Soldiers can only hit; the kill comes from the weapon designer. Where is the soldier's reward if he hits but doesn't get a kill?

Having problems with equipment that works on the bench but not in the field, after it is installed.

Overall experience with MILES is satisfactory; it is used routinely.

Would be willing to accept adding a card or swapping a card in the gun computer to get such things as ranging and superelevation. But a training system failure must not interfere with weapon function.

MILES batteries are replaced at least every other day, sometimes daily if exercises are intense.

BITE would be very desirable, especially for the TES systems with many components and cables such as for the Bradley, the M60, and the M1.

A sensor on the back of the M1 turret is shielded by the smoke launcher.

Having the sensors only on the turret causes problems: the flank tank with turret pointed at you versus the tank pointed at you with a flank turret.

Some tank detector configurations don't have any sensors exposed on the rear of the tank.

Provisions must be added to play mobility kills and weapon kills. A mobility killed vehicle immediately launches smoke.

Individual crew kills become very important in MOUT.

Wouldn't want to see the next generation TES system any larger or heavier; the helmet units are the worst, including the problem of being off-balance.

Head shots may not be all that important.

Area weapons might be handled by instrumenting only one man in a squad since, by doctrine, the squad always stays together.

Data gathering would be very desirable from an AAR standpoint; position location would be necessary.

Mentioned the Multiple Object Locator System (MOLS).

Mentioned SIMNET, which may use the Saab BT41.

Beam spread for MILES has been a problem.

Mentioned first generation LTIDDS with one sensor, MILES-equiped targets.

The M1A1P will have an eyesafe $CO_2$ laser rangefinder which may not be MILES detector safe.

The manual for tank training devices is an inch thick; these many separate devices and systems must be integrated into a single system.

Army Trainer (magazine) March 1986 describes TELFARE, an M1 50-cal. trainer.

Need TES on targets than can shoot back on live fire range.

Need to take into account the vulnerable area of a weapons platform. The $P_k$ needs to change from front to rear, to side, etc., not just the turret.

Imbedded TES: use in combat for training of troops before they use live ammo on threat target, cost effective, enhancement of survival, increase kill rate, train replacement crews, keep people up and running; this would follow Patton - train all the time.

Integrate TES into the vehicle gunnery capability and equipment, use sight and computer. This is the same as Chemical Alarms trainig mode.

Firing a new generation gun is like an aircraft check-off sheet; it's complicated and won't work if you don't do everything on the list.

Need to use TES at all levels of training.

Need individual crew kills in a tank or APC.

Need target hit signatures for identification of damage so others in battle can fire (this assumes that partial damage is of importance).

TES will be integrated in combined arms battalion task force exercises with exchange of companies of infantry and armor at NTC and Ft. Hood.

Need artillery with time fidelity near 2 minutes in accuracy.

Need 300 sets of MILES for use by the III Corps combat vehicles.

Have several newer types of TOW weapons with differences that MILES does not simulate, like range, all of which could be used by anyone in exercise with resupply. This means that TES will need to identify which missile crew is doing what.

For US heavy mechanized divisions, the embedded TES could be different and could be left on the vehicles because these particular vehicles would not be used in combat since they can't be taken with troops. Troops would obtain vehicles from deployed equipment. The same is the case with heavy Reserve Forces.

Don't like having to clean the carbon left after firing the Hoffman devices.

Need to integrate day smoke operations and night obscuration into force-on-force exercises.

Need to deal with unintentional fratricide during training exercises.

TES/3:209

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-127-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 2nd of the 7th Cavalry, 1st Cavalry Division, Ft. Hood, Texas, March 19, 1986.

LTC James Riley
MAJ Illing

Comments:

"MILES is the best training device we have; it's better than Big Bullet or UCOFT".

Found that the MILES transmitter was coming loose in the Bradley TOW hammerhead; the MILES mounting bolts were too short. Would lose boresight after 30 minutes of travel.

With proper mounting, MILES Bradley TOW will kill, with six-foot error at maximum range. The dismounted TOW is an even better tank killer.

The 10-second hold on time for MILES TOW is a problem; it should be adjustable.

The MILES Bradley 25mm cannon kills dismounts easily at 3km at night using HE rounds and the thermal sights; this may be unrealistic.

The MILES 25mm weapon firing signature (flashing light) is inadequate.

The transfer of gunnery skills on the Bradley 25mm cannon is not good: no range selection, no superelevation, no ammo differences.

Filters to make laser rangefinders eye-safe are not allowed at Ft. Hood or NTC.

MILES systems have too many cables.

Since MILES lasers don't penetrate smoke, use of smoke by OPFOR at NTC may give them an unrealistic sense of security.

The MWLD torso harness is dangerous when worn by the crew in the Bradley vehicle, especially in the turret where even the combat web gear is dangerous.

The helmet detector harness comes off too easily; its too heavy and unbalanced.

The weight of the MWLD torso harness is OK, but it won't carry everything a soldier likes to carry.

The MILES support personnel only work 5 days a week, but the units train 7 days a week.

The MILES Viper and Dragon simulators break easily.

There are too many false kills.

TES would be better if it were a way to do primary (or preliminary) gunnery training.

TES needs to remain user installed.

An imbedded TES system would be good. If unit were sent to combat in Germany, there might be 20-30 days when training was desirable.

TES TOW should be played with all three types of TOW missiles.

Need different kill codes for the different TOW weapons: helicopter, ITV, ground, etc.

Not interested in additional data collection in future systems. "We treat things in a sort of macro mode".

On a particular vehicle, MILES may be taken on and off ten times a year.

LTC Riley's vehicle traveled 1000 km in his last rotation at NTC. His battalion goes to NTC once a year.

There are 180 training days a year for this unit. 50% involve vehicles, most of them using MILES.

Multiple detector belts on a vehicle would be desirable, but are not a big issue.

This unit changes MILES batteries every third day. In Germany, at 20°F, they were changed every day.

The various types of kills (mobility, weapon, etc.) are handled by controllers; this is adequate.

TES should not support just maneuver training, it should also include training of skills and gunnery.

MILES torso harness is not strong enough to use for the real web.

Casualty cards are adequate for type of kill.

Need to simulate the round (HE, AP, direct, indirect) and its effective range. TES should require more than the gunner having to push just one button to fire the weapon.

Need to practice ammo conservation, logistics and vehicle ammo loads. TES simulation and simulators should duplicate the amount and kind of ammo that can be carried and let the commander select what to take on a mission. At NTC, Col Riley used nine basic loads in his force-on-force missions. One should not have to reload, etc. TES before one would do so in real world.

Need to have TES provide more realism for the weapon and integrate with the real world.

TOW time-of-flight is OK for maximum range, but TES should not require gunner to hold on target for the full TOW flight duration for every firing. A lot of targets will be at short ranges.

Need to identify the TOW platform that obtained the kill for After Action Reviews. (AARs)

Fratricide is a problem that TES should address for AARs; need to be able to identify who shot who and when.

TES/3:127

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-185-86
July 10, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with TRADOC Systems Manager (TSM), Joint Readiness Training Center (JRTC), Ft. Monroe, VA, March 26, 1986.

COL Larry Word, TSM-JRTC

Comments:

Force-on-force training can be the equivalent of the first ten combat missions.

Readiness: The cost of training is pennies compared to the investment in tactical equipment.

Squad-level training is probably the lowest level of training with any degree of formality; TES is hard to use above the battalion task force level.

MILES solves only some of the control problems and none of the evaluation problems. There will always be a need for controllers.

Controllers/evaluators need to determine the 'why' of a result which MILES defined as a 'what'.

There is only so much 'discovery learning' that can occur, a good After Action Review (AAR) is required for the remainder.

SLA Marshall developed the technique of interviewing survivors. In the AAR, everyone participating is available, including the survivors and the OPFOR.

Controllers learn more than anyone; they are not simply administrative overhead.

Multi-echelon training is squad, platoon, and company exercises conducted simultaneously; requires AAR at each level, which means precise feedback from observers at each echelon.

The example given by NTC AARs is causing more and more emphasis on using AARs at home stations.

The outcome of the first ten squad level exercises can be accurately predicted because it will take that many, using good quality AARs and engagement simulating to achieve the objective successfully. "This means a whole lot of training needs to be done. This isn't happening now because there are hardly any objective, measurable, standards in the existing ARTEPS."

Example of an objective standard:

COMPANY ATTACK MISSION

"The company will accomplish the mission, and seize the objective, without sustaining more than 10-15% casulties."

(Time limits are not used. Casualty loss level picked so as not to cause the unit to become ineffective.)

See MILES TC 71-4 (Coordinating Draft) 22 September 1980, "How to Plan, Prepare, and Conduct MILES Training".

There is nothing wrong with US tactics vs US tactics at the squad and company level at the home station; OPFOR appropriate only for battalion level ARTEPs.

New TES must include Air Force weapons, laser designators, area weapons.

The Army usually tries to go too far in simulation realism; don't try to hang every bell and whistle on the new TES.

Indirect fire simulation must include the guns, the signatures, the casualty effects.

For a Battery-1 (8 rounds), there should be a least 2-3 cues in the target area; for a Battery-2 (16 rounds), there should be 3-4 cues.

There must be a distinction between camouflage and cover, i.e. leaves may be camo, but they're certainly not cover.

Imbedded training systems may be more saleable if they have some operational application.

It must be necessary to go through exactly the same steps to fire TES as to fire a real round; however, TES is a "collective training system", not a gunnery trainer.

Shootback targets are unrealistic; a real person should be making the decisions.

Battalion level live fire is a waste of time and money; rounds fired vs number of holes is zero feedback. There is no indication of who shot, when, etc. Maneuver training benefit is lost in the excitement of seeing rounds go down range.

A TES system that replicates gunnery is a good idea; it could tilt the outcome of even a battalion-sized exercises. It would also teach good gunnery on a continuing basis.

Thermal-defeating smoke is about to become available. As a result, MILES in smoke may no longer be a problem.

Need more precise kill probabilities which consider such things as tank attitude.

Mobility kills are needed to play combat logistics support, i.e., retrieval of damaged tanks, which is now done at NTC.

How far should we go to prevent cheating by mechanical means? Answer: not far; the approach to cheating should be through discipline.

Number of controllers at NTC:

One per platoon
One per company commander
One per squad in denser terrain

The resources for controllers should come from two levels above, i.e. controllers for a platoon should come from the battalion.

The reliability and maintenance for MILES is borderline acceptable. Biggest problems are Dragon, Viper, and individuals' torso harnesses. The latter are susceptible to RF kills and wear out with time.

Except for TOW and Dragon, MILES batteries are changed at NTC only when the system goes dead.

Vehicle power should replace batteries wherever possible.

New TES must retain the simplicity and durability of MILES.

Firer's ID must be added to pairing data; it will help gunnery.

New TES must include Claymore mines, pistols, detectors for soft vehicles, hand grenades.

New TES must retain signature effects.

The MILES VKI flashing light is adequate. Getting rid of hit smoke was a good idea; all real kills don't smoke.

Training time can be 1/3 training, 1/3 post support, 1/3 off to school.

There needs to be more fidelity in the simulation.

Colonel Word would eliminate much of the Division FTXs and replace them with small unit (such as squad) training. They would get more out of it.

He commented on how people learn things. During the first or second time a mission is accomplished, most of the effort is just moving around and understanding and improving the movement. If you do something between a squad and a machine gun, you find that, on the third, fourth or fifth time, the squad usually can take the objective with 60% or 70% casualties. By the time they have achieved the seventh or eighth repeat cycle, they've managed to reduce it to two or three casualties and have still taken the objective. Training needs to be repetitive.

Use TES to overcome the decay in training.

Need various weapon systems to play together. Need the total weapons platform to work, for instance on tanks: main gun, MG, and the smoke action, the FASCAM, chemical, Air Force.

Laser designators and range finders need to be eye-safe so they can be used in training.

Artillery needs to have a signature and a real-time casualty assessment. The forward observers need to do something. Time fidelity for 8 tubes: probably two minutes is quite good with regard to a total system. If you had 16 tubes, your fidelity would need to be 3 to 4 minutes.

Mines, camouflage and cover need better simulation.

How they played FASCAM at NTC:

a) They used a yellow smoke signal because the OPFOR says they could obviously see them and were devastated by them. The line troops feel that an area of typically 400 meters by 400 meters was good.

b) If tanks went through a minefield then there would be some casualties; 85-90% would make it through if all the tanks went through the same path. If a following tank, for some reason, had to deviate from the path that the first one went through, then they would have 40-60% make it across.

In the training there needs to be something with regard to IFF (Identification, Friend or Foe).

Need to have some kind of fidelity for Germany, since the local training areas are far too small to conduct good MILES training.

They need to do something with smoke and dust or thermal defeating smokes.

They need more precise kill probabilities, for instance, the front slope of a tank.

Need to do something with regard to damage; the combat service support needs to have some system to work on damage; they could use the same system as in the chemical or medical in which they are told what they should do based on something realistic and something statistical.

There seems to be some minimum number of cheaters; they will really not make much difference in what the mission end result is, so that it doesn't make much difference if they cheat.

Controllers: At the NTC, you need one controller per platoon, essentially one for each commanding officer. The controllers typically can mirror the officer cadre. If you're going to do a good job you need one controller per squad. This would be an NCO. A senior controller would be a platoon leader or a company commander.

There needs to be a reduction in the weight of MILES so that for a person working a MILES system, weight is within 10-15% of what he normally carries. As an example, for an anti-tank gunner in Dragon and Viper, the TES system needs to include the weight of ammo.

Signature effects: Everything needs to have a hit signature. There needs to be a mechanism to let the controller know who hit what. One needs to know when you have a hull penetration versus some other kind of kill.

There needs to be ability to use the TES at night.

Need to do something with regard to operating with NATO.

TES/4:185

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-108-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at Army Training Support Center, Ft. Eustis, April 11, 1986.

LTC Sasin
SGT Westover
SGT Muoci

Comments:

MILES TASC and Contractor Logistic Support (CLS) in Korea is at Camp Casey, near the 2nd Division and the DMZ. Other combat units are 25-30 km away; the Army feels this is too far.

MILES equipment usage is scheduled quarterly with TASC, the only one being at Camp Casey. It is usually kept for 2-3 weeks.

The US Army Audit Agency (USAAA) did a study on the effects of distance between units. See Triple-A Audit, June 85 to Jan. 86.

Logistics problems for training areas in Korea are similar to those in Germany.

The cold in Korea is worse than in Germany.

In Korea, more training is done in the winter because of the greater crosscountry maneuverability.

Equipment doesn't get as much maintenance when it is very cold. This impacts anything that has to be installed.

MILES has been used at Ft. Riley at -20°F.

In Korea, the training ranges are Nightmare (4 km x 6 km) and Rodriguez. They are very restricted for live fire.

The Korean equivalent of Reforger is called Team Spirit.

Maneuver damage in Korea is high.

MILES was designed for use at the squad, platoon, and company levels. Bigger exercises require too many controllers to be practical. NTC is the exception.

The Combat Maneuver Training Center (CMTC) will use company-sized maneuver forces. Probably at Hohenfels, Germany by mid-1987.

MILES teaches you that if you make a mistake, you're going to die.

Centralized storage and issue of TES is the only way.

TES distribution must be kept close to CLS sites.

The Loral-operated CLS sites work well. 90% availability is the goal and it is usually achieved.

There are two CLS sites in Alaska, Ft. Richardson and Ft. Wainwright. This is a problem.

Cheating is a problem.

Imbedded or newly designed TES equipment should be smaller, have fewer cables, fewer component boxes.

The LHX helicopter is planned to have some MILES imbedded.

A high percentage of Cobra TSUs have the MILES laser installed.

The Apache TADS may have provisions to line-replace the laser rangefinder with the MILES laser.

The Cobra TSGMS is too complicated.

AGES II has a requirement for an eye-safe laser designator.

New TES should be easier to install for the user.

NATO: TES should be interoperable with NATO equipment such as SIMFIRE, it should be able to engage with NATO forces and their equipment.

Imbedding of the next TES system into the weapons systems means training equipment is always available: the system should be like a canteen, rifle, or sleeping bag which the soldier carries to the field just like any of his other equipment, so as to use it at any time.

Controllers need to have more information. Automatic data collection: they need to know who did what to whom and when. The organizations need to know the same thing in the After Action Review (AAR).

There is a concern with regard to noise abatement. This refers to the use of the training center near civilian populations for training.

The new TES system should do both training and gunnery.

Korea has both cold and hot weather conditions.

Try to integrate the TES into the rifle so that it is more usable and balanced as a weapon. Should move the laser transmitter - not hung on front; one place to put it is in the stock.

Going and getting MILES equipment requires that the unit use organic transportation system which is usually difficult. In Germany, rolling an automobile along a road is one thing, rolling 2 1/2 ton trucks is a big effort.

As an example of installation, on the Cobra aircraft the experienced person should put on MILES in 1 1/2 hours. The first time that one tries it, one would expect that it would take all day to install.

A light should be adequate as a cue, such as a flashing light on an aircraft.

Switchology should be learned and used through TES.

It is not clear that one really has to have a hit signature that replicates anything.

In the winter, it is very difficult to clean the MILES system or conduct outdoor installation, especially putting on the velcro tape; nobody likes to glue on the velcro tape as it always comes off. They want to get rid of the belts.

With regard to firing MILES through foliage, if you are not seen then what difference does it make. Maybe it is realistic that MILES does not fire through the foliage.

They have joint task forces at company level (mixing of platoons from different companies) as well as units attached for missions at battalion or brigade levels.

The CMTC at Hohenfeld will be for a company-size exercise in an instrumented range, to be built and operational sometime in mid 1987.

Maintenance for TES should be a similar approach to what they now do: minor fixes only and exchange of broken one with TASC; TASC sends bad ones back to maintenance station.

A sound or noise cue is needed for troops in the target area when these troops cannot see visual firing cues.

The cues should be issued from the weapon itself, like the MILES M16 rifle blank ammo, such that the cue is loaded like the weapon ammo and the weapon actually fires the cue.

Eye-safe lasers for laser target designators, rangefinders, etc., should be used in force-on-force training exercises. TES should simulate these if real ones are not safe to use.

Germany has a mild, wet, and windy cold in the winter. In Korea there are extremely cold winds out of the north.

They were able to fire a MILES laser through some styrofoam packing material which was not expected.

Intervisibility is not a training problem. What troops don't see or know about doesn't hurt. Also, what they don't fire at, they don't hurt.

TES/1:108

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-121-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 11th Armored Cavalry Regiment, (Aviation) Downs Barracks, Fulda, Germany, April 15, 1986

CPT Gary Skubal
1LT Bartolec
1LT Tucker

Comments:

| | |
|---|---|
| Regiment: | 1 aviation, 3 ground squadrons |
| Squadron: | 2 attack, 3 cavalry troops |
| Cavalry Troop: | 5 scout helicopters, 3 Cobras; recon mission |
| Attack Troop : | 3 scout helicopters, 5 Cobras; destroy mission |

Don't use MILES because putting MILES in the TSU decommissions the aircraft due to removal of laser rangefinder.

Other units in Germany may be using MILES; degrading of tactical equipment is the local commanders decision.

There is practically no engagement training for this unit now; anything is a special exercise.

In Germany, laser rangefinders can only be used at the live fire areas - such as Grafenwohr.

They get to live fire twice a year (but not necessarily at 6-month intervals).

Airspace control is a lot easier in Germany; landing rights are universal in Germany.

Apache is a couple of years away.

Air-to-air is a "dirty word" in the Army due to flying tactics and loading forces on the helicopter during maneuvers. [In addition to structural changes, a higher rate of fire cannon (1500 rpm vs 750), plus a new fire control system, are required].

Marines train for air-to-air using a different model Cobra.

They fly with NBC gear once a year.

Each troop is supposed to run a tactical scenario once a week, but this is done only about half the time.

SFTS (or SFWTS) is used about once a month (but not at Fulda) for flight and gunnery simulation. The visual cues are poor.

Ammo will become harder to get, gunnery training and simulation will become more important.

Coordinating with scout helicopters and the rest of the team is important to train.

They do play EMI with a Military Intelligence (MI) unit attached to the squadron. But EMI can so effectively shut down a unit that it is seldom played. Its use would require a policy change at the highest level of the Army.

If MILES could be used, it would, enthusiastically. A troop with MILES could go out, without much preplanning, and do force-on-force with the regiment's own stinger teams.

The 11th ACR had enough MILES to equip 10 Cobras, 6 OH-58s, and 6 Hueys, and was unaware of it for a long time.

MILES hit signature smoke is a problem as it has to be de-armed when entering the refueling area.

Not happy with there not being different MILES kill codes for ground TOW and airborne TOW.

After battles, it's "playtime" and everyone gets shot at. A big problem at NTC was getting killed by your own side (due to boredom).

The 6-volt battery in airborne MILES is somewhat of a problem. It had to be changed often, especially in hot weather.

MILES belts on the helicopter are not a problem. They were used at Hohenfels and were mounted for the trip down and back from Fulda.

Using controller guns for weapons is not satisfactory simulation. Also had problems due to long range and ground mist.

Would have plenty of people available to do controllers' duties, summarizing of AAR data, etc., would like AAR data similar to what is recorded at Nellis AFB during Red Flag.

Enthusiastic about video, such as video gun cameras slaved to the TSU. They liked the Israeli gun camera pictures showing TOW kills; they were surprised to see kills at 500 meters.

Video could also be used to document exposure time.

Would be interested in intervisibility measurement. "Training is more than simulation".

In real combat, tracers show where the incoming fire is coming from. Gun flash is not nearly as important; present MILES flashes are not big enough. Buzz in a headset might be a method.

Now, the miss signal, and especially the kill signal go off and it's a surprise since not being targeted.

A ZSU can be avoided if the flash of the gun can be seen since it takes 3-4 seconds for bullets to reach the aircraft.

They don't seem to be getting enough kills from any of the weapons - TOW, 20mm cannon, or rockets.

Using Improved TOW, with an advertised range of 3750 meters, beyond about 2500 meters is not reliable due to upward pitch angle at impact.

Improved target hit resolution is not important; present doctrine is to aim at the center of mass.

Inert warhead TOWs are used for gunnery training. Noise (very loud) and initial observation are important in first time firing of TOW.

It is very important that MILES requires exactly the same steps as firing the real weapon.

They are not training with smoke now; felt it should be done.

Shooting into foliage is not a problem since it isn't done in combat; it's too hard to find targets.

If the training system could verify that the real weapon was properly boresighted, it would be a very high priority item on the weapon.

A Ground Environment Threat _ _ _ _ (GRETA) vehicle is used to simulate the ZSU.

A Tactical Radar Threat Generator (TRTG) is based at Hohenfels. This is a good system. They train with it every 6 weeks. There is a short learning curve with it.

The Hydra-70 is a much more potent weapon than the current 2.75 inch rocket that it will replace. It should be simulated with MILES, along with the TOW and the 20mm cannon.

Helicopters are resupplied at central locations called Forward Area Rearming and Refueling Points (FARRPs). This can take an hour or more and should be simulated.

A MILES system for the Blackhawk is needed.

Should look into combining the functions of several lasers - MILES, rangefinding, designating - into a single one.

They have the following needs: a) night capability for combat, night sights, night goggles simulation, b) casualty assessment to individual in aircraft, c) go-gun for aircraft, d) a dry fire system to do checkout, e) operate in marginal weather, f) rocket and gun simulators, g) replace live fire with 20mm trainer, h) same constraints as weapon, i) crew member switchology, j) to bore sight often, k) eye safe lasers for designators and rangefinders, l) MILES to kill in haze and fog when that target that can be seen with naked eye, m) reusable hand grenade with marker.

They have to loosen belt for battery check on aircraft.

Simulation of armor $P_k$ for Improved TOW at 3750 meters.

TES/5:121

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-129-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 11th Armored Cavalry Regiment (Ground), Downs Barracks, Fulda, Germany, April 15, 1986.

| | |
|---|---|
| CPT William Ward | A Troop |
| SSG Donald Gruber | A Troop |
| CPT Kris Thompson | C Troop |
| SSG Truman Payne | C Troop |
| 2LT Steven Karaffin | Regimental ADA |
| SFC Harold Dreschler | HHT |

Comments:

They do platoon-level ARTEPS at Hohenfels once a year, using Target Instrumented Detector System (TIDS)

TIDS takes a full day to set up.

MILES is good for M1 gunnery training.

Need a reticle offset for the M1 sight, a well as something to cancel superelevation.

When selecting between the main gun and the coax, there is not enough reticle movement in the sight for the coax. Boresighting at 500 meters, instead of the book valve of 1200 meters, improves this situation.

The MILES detector location on the back of the M1 turret is poor.

The MILES laser/sight misalignment, when boresighted at 1200 meters, gives too many misses at 400 meters.

The MILES system needs to be more user friendly. Multitude of boxes and cables aren't.

The MILES test box is much too complicated to use.

Going through trees, belts end up wrapped around the tracks.

MILES on tanks can be reloaded by jamming a mechanical grease pencil in the keyhole.

Cheating is an Article 15, but keys must still be eliminated. This is a problem worth spending money on.

MILES is now too dependent on the judgement of an evaluator.

The MILES laser is no good on a hazy day, even when targets can be seen with the daylight sights. It might require getting within 600 meters to work.

Hoffman devices can be turned off to become "silent killers".

It should not be possible to kill a man with a tank main gun.

If MILES were easier to put on and take off, and easier to maintain, it would be used more often.

There are few informal exercises; it takes too long to put the MILES equipment on.

The 3rd Squadron only used MILES one time in a year.

Four MILES exercises a year is a lot for a platoon; twice a year is more common. This may be peculiar to the 11th ACR, however, since they have an assigned mission: patrolling the East German border.

Twelve tank rounds shot per exercise would be a lot.

72 hours is the maximum length of one of the twice-a-year platoon exercises.

Use of smoke is very restricted in Germany.

They have very limited play with other nationalities.

They haven't had problems using the MILES - Bradley TOW; one reason is that they have been well checked out by the Loral rep.

They have excellent support from Loral, particularly due to the efforts of one man, a Mr. Vanlandingham. Before him, MILES reliability was poor.

They have small, short duration, repetitious exercises; they don't need things like commo kill or mobility kill.

Burst on target (BOT) would be very desirable.

Need to add the firers ID, so that this record is available in the AAR.

Action on contact is more important than the AAR as far as crew evaluation is concerned.

M88s are used during ARTEP exercises, but without MILES since there are no MILES sets for the M88. It would be desirable.

Shootback targets wouldn't add anything since gunnery is done against a stopwatch anyway.

They replace batteries when they go dead; the supply of batteries is limited.

It is important to have the MILES system on all the time so that you can be killed at night when you are sleeping.

The helmet detector belt doesn't fit the new Kevlar helmet.

Standard procedure is to take the MILES body harness off when in the turret.

The initial evaluation of MILES in Europe included an artillery simulator.

Artillery is now simulated with purple smoke. All OPFOR artillery is assumed to be chemical. Any time there is purple smoke, crews are supposed to button up and put on MOPP gear.

Must add sensors to tops of vehicles for new weapons as well as to prevent targets from parking on steep slopes to avoid being killed.

Maneuver Rights Area (MRA): Typically about 5km an a side.

They go to Hohenfels about once a year.

Don't need MOUT training, in combat they would bypass the towns (tankers don't like towns, too many traps).

Simulating mines is an important need.

German training environment: their local training area, which can be used at any time, is about 5x5 km in area; they can use a Maneuver Rights Area, 20 km sq. for one month each year.

They use MILES one time per year for each platoon ARTEP; a troop would use two times a year. Each unit will go to Hohenfelds about every other year. Wielfleken is their live fire range; they use MILES with live fire. They don't use MILES in REFORGER, but they have need to use it.

They, the CAV, need to be able to train in small units: platoon and troops; the recon and scouts need to train as squads and sections.

They need the following: a) blank round or better fire signature simulator for The Bradley Coax, b) ability to dry fire for checks, etc., without signature effects, c) to keep up with new weapons like 3700-3800 meter main gun, d) mine simulation, and e) Air Force or Army Aviation fly over.

They need to have a drive-in MILES installation site for vehicles at battalion like at the NTC.

They need a two-week course on how to install and use MILES; it should be given at NCO school.

They need the following: a) to be able to laser designate and range a target saftey, b) the weakness of hull integrated into $P_K$, c) to be more real world: to be able to make repairs, to use alternate means for gun fire control, etc. d) zero MILES on rifle by moving MILES not rifle sight, 3) sense of hitting target and being hit, f) antenna removal for both direct the indirect fire weapons, g) mobility kill effect, h) MILES kit for hits on all systems in the exercise like soft targets (maintenance and recovery vehicles), h) Stinger section TES which is a Corps asset attached to them.

They need the following in MILES: a) ability to reset false kills, b) have controller-enable be easier to use, like from outside the vehicle and from a distance, c) have a cheat indication on each system for controller to check, d) no web gear is worn by tank crews; need RTCA for individuals in order to play real world stress of crew casualty effects.

For After Action Reviews they need the following: a) a position location system like Global Positioning System (GPS), b) playback of selected data, c) sequence of events, d) to know what the action was on contact.

They need for gunnery: a) standard for a simulation system to qualify; they would use about four times a quarter; they do not obtain enough gunnery reinforcement and retention training, b) shoot back targets to train for minimum exposure.

TES/1:129

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-125-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 52nd Mechanized Infantry Battalion, 1st Armored Division, Warner Barracks, Bamberg, Germany, April 17, 1986.

| | |
|---|---|
| CPT Paxton | CPT Howell |
| LTC Sorrell | 1LT Bailey |
| CPT Streff | 1LT Dannon |
| CPT Dettinger | |

Comments:

The 52nd Mech Infantry was getting ready to go to Hohenfels with four companies for a MILES instrumented exercise

Hohenfels is maneuver; Grafenwoehr is live fire only (except MILES ITV TOW has been used there). Wildfliken is also live fire only.

Maneuver Rights Areas (MRAs) are typically 20km on a side. Local Training Areas (LTAs) are typically 1 km on a side.

Exercises on MRAs are usually company size, without MILES.

There are maybe only a couple of company-sized sets of MILES at Bamberg for the 25 to 30 companies there (8 battalions). There is one month lead planning to get MILES.

Vehicles go to Hohenfels from Bamberg by rail. They are there about 10 days, 6 days with MILES installed, once a year.

They supply their own controllers for company exercises at Hohenfels; use "external" controllers when they have battalion-size exercises.

They use MILES at Bamberg only on squad level exercises with dismounts only, rifles and machine guns.

Uninstrumented exercises on MRAs are usually not force-on-foce; they are done to solve specific problems such as vehicle retrieval.

They see 'suicide attacks' through smoke since the soldiers know MILES doesn't penetrate smoke. Smoke is used extensively at Hohenfels, but no where else.

At the Ranger School at Eglin AFB, 12-day exercises worked too heavy a toll on the man-worn harnesses.

It takes 6 months to get batteries for MILES. They are used then only once a year and have no other purpose.

The MILES helmet attachment must be improved, but the weight is not a problem.

The rifle-mounted laser is too heavy

The soldiers cheat, try to outwit MILES. There are enough maintenance problems that finding the culprit isn't easy.

Tank commanders (TCs) in the M113 have the same problem as experienced in the Bradley: wearing it in the vehicle is unsafe (snagging).

Batteries fall out of the boxes on the harnesses and the helmets. The battery box screw wears out. The snap strap on the rifle laser battery cover is better.

Troops don't engage with MILES at ranges that are as great as they would be in combat because they don't think they get enough hits.

MILES doesn't teach gunnery because the soldiers don't zero MILES.

Not seeing impacts, lack of suppression firing, are problems.

There is much too high a kill ratio with the MILES - Viper.

MILES TOW is good only out to about 2km. This is too close for combat. 1200m is about the maximum usable range for MILES TOW.

There is difficulty in seeing through the MILES TOW sight on the ITV.

The tactical TOW night sight cannot be mounted on top of the MILES TOW day sight.

There is a problem with carrying only one Viper on LAW weapon when it can fire 4 MILES rounds.

The MILES keys need to be eliminated. They are counterfeited, lost, etc.

Loud sounds will set off nearby MILES rifle lasers.

The ATWESS signature is too small; need to think about the after-launch obscuration, weight loss, etc.

MILES lasers ricochet in foliage.

MILES doesn't have a high enough casualty rate in small arms fire.

The objective in future systems is to be able to train the way you fight.

Not interested in simulated mines because of the accountability problem. They now use roped off areas and wooden blocks.

Do want artillery and air-ground engagement simulation. In MOUT, MILES won't shoot through doors, doesn't simulate ricochet.

MOUT training is mainly for dismounts. Won't take tanks into towns; clear them out with infantry.

Not interested in simulation of NBC or mines; they are still working on the basics.

They will be in MOPP gear with MILES at Hohenfels for a couple of hours.

They won't have Bradleys for 3-4 years. The actual date is classified.

Need to play small arms against aircraft (as is done in Afghanistan); MILES doesn't teach lead.

Casualty cards are not a good method. Need to know where MILES hits on the body; only need about 25% resolution.

An infantry system, for M16s and M60s, should be looked at as a separate system.

In MOUT training, MILES can't be used at short range (25-50 meters). There is no sensor in the middle of the chest. Can't fire MILES at less than 25 meters because of hazard from firing the blank. Should be able to simulate engagements down to 5 meters.

The MILES torso harness snags going through windows in MOUT.

A simulation system dedicated helmet would be OK, but not a system rifle; the man's personal M16 must be used.

The M208 vest might be a candidate for built-in detectors.

A better place for the battery and electronics on the MILES torso harness would be a simulated ammo pouch.

A test light for the batteries would be very worthwhile. Another good idea would be a test light for sensors, are not driven buttoned up. So therefore, what is the purpose of SAWE?

Need a simulator for the 4.2 inch mortar.

Black smoke for a hit signature would be an improvement; should last for 30-60 seconds.

Handing off an M60 machine gun must be possible with the simulation system; it is done in combat.

The sound of the blank round is very important.

"Don't make SAWE too big a killer; we don't want to demoralized the troops as for how horrible real artillery is".

No need for different firing signatures for different ATGMs.

Should be able to make a jeep into a tank; it's important to fill in the voids in available vehicles.

VISMODS are extremely important.

On the SAF, need to change the "Canadian Bull" to a silhouette.

Get plenty of gunnery training at live fire; don't need any MILES gunnery simulation.

MILES works better in MOUT training than in other areas because there are no trees. MILES has problems in vegetation.

Would like to have simulator for the hand grenade.

Minefield simulation would not be worth the cost.

There are plenty of training areas in Germany where TOW engagements can take place out to 3km.

Viper, TOW, Dragon simulators need to be as close as possible to all the firing characteristics of the real weapon.

Would like to have to load weight-simulated rounds into the TOW hammerhead on the ITV.

Simulation systems should be designed for squad-on-squad exercies as well as for company-on-company.

Infantry needs to know where it got hit.

In M113s, the driver and TC have their heads out, but don't wear MILES detectors on their CVCs vehicles.

They have the following TES needs: a) use during Reforger. b) Cheaper because of lost equipment cost to troops (helmet sets are $300 to $400). c) more of TES available to unit than MILES. d) simpler to install and use. e) use of TES in smoke. f) they need to simulate the night and thermal sights: night training is 50% of their training.

MILES web, laser mount and parts wear out too fast.

Local Training Area accommodates a squad dismounted.

They will have more urban (MOUT) than field maneuver training.

Personnel turnover is problem for gunnery crews qualification.

Need mines at Hohenfels, but not at local unit training areas because of accountability if not disposable.

TES/1:125

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-124-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep

SUBJECT: Tactical Engagement Simulation Meeting with the 52nd Mechanized Infantry Battalion, 1st Armored Division, Warner Barracks, Bamberg, Germany, April 17, 1986.

| | |
|---|---|
| SGT Harris | SGT Redding |
| SGT Murphy | SGT Dore |

Comments:

MILES keys can be, and are, filed down.

Need some kind of marker on the target to show where it was hit; this would alleviate the problem of false kills which are not by enemy fire.

Would like to have different colors of smokes for hit signatures to indicate different kinds of hits.

The MILES electronics/battery box on the man-worn harness is very uncomfortable under the rucksac. Worn over the rucksac, it flops around, doesn't register hits.

Get too many kills on the man-worn system due to the laser pattern hitting too many detectors.

MILES TOW not effective over 1700 meters.

The combat TOW night sight can't be aligned with the MILES TOW day sight.

There is no simulation of the Dragon night sight.

The M16 MILES laser can be wired (through the dry fire connector) so the laser fires continuously.

MILES keys can be filed, then used so that the wearer can be near-missed, but not killed.

The M60 machine gun will set off detectors on the operator; it may be concussion or reflections.

Cheating is an on-going problem, not cured by command policy.

There should be a higher penalty for getting killed. Some people try to get killed early so they can go home.

Need firer's ID so that kills can be distinguished between friendly (crossed your sector of fire) or OPFOR.

Users need to be taught how to use MILES.

Not sure it is a good ideal to have MILES equipment resident in each company.

Will not wear the man-worn harness in an ITV as it is hazardous.

Even getting out of the back of an infantry track is a problem.

TES/1:124

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-122-86
June 3, 1986

TO: D . ibution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 1st Armored Division Artillery and Aviation, Katterback Caserne, Katterback, Germany, April 18, 1986

1LT Robinson C Battery, 6-14 Field Artillery
(LT Robinson is the FSO for a maneuver battalion.)

Comments:

Company commander: "We're coming up to the bridge site now, so everybody turn off their MILES".

FASCAM simulation is unrealistic: delivered too fast and in too much mass.

Damage assessment for artillery is unrealistic.

Smoke and white phosphorus are important artillery tools and must be used in training.

Smoke, the 30-minute smoke screen, is overused in training now.

Differences in Germany: the environment, Reforger twice a year, more fast-paced, bigger percentage of the year is in training and maintaining, climate, terrain (forested areas), population density, use of buildings.

Use eight guns per battery; the fire elements may stay in place a little longer.

Maneuver is an important part of Reforger.

One artillery battalion supports a brigade, there are three artillery batteries in a battalion. There are also three infantry battalions in a brigade.

81mm mortar batteries are being used in the light infantry.

Also using Lance and Pershing, as division artillery.

Copperhead is being trained. Subscale trainers are used for laser designation practice; a model missile is used to practice assembly, setup, etc.

Artillery is a very complex loop: battery, FDC, etc. It is easy for something to go wrong in live fire and for someone to be killed.

They are starting to use Local Training Areas (LTAs) now (April) to get ready to go to Grafenwoehr in June for an ARTEP.

Simulation at the battery: need to train against being attacked by ground units and aircraft. Simulation weaponry is required for the reaction force. Need to be able to use MILES, both detectors and main gun lasers. They train for this now during live fire at Grafenwoehr.

Not interested in dummy (blooper) rounds.

During Combined Arms Live Fire Exercise (CALFEX), a company-sized maneuver element is directed toward a target area that is then pounded by air (A10s) and artillery. It's a very impressive demonstration of artillery for the maneuver elements.

Artillery units are overrun and fired at regularly in exercises. However, when it is seen that they have no MILES, they are passed by.

Most actual artillery bursts are ground bursts.

The US Army does not train the delivery of chemical rounds, but does train the use of MOPP gear and decontamination.

Both the receipt and delivery of nuclear devices is trained. The present gasoline drum simulation of nuclear burst needs to be improved, made larger.

Variable time delay (VT) artillery will attrit M113s. Bradleys? Don't know.

Commanders don't use artillery until they learn what it can do; TES needs to demonstrate this.

They could use danger range of 300-350 meters downrange from artillery TES round simulation; this would be same as real world.

They have the following needs: a) exercise FIST team. b) 1 to 1 artillery shell simulation with recoil. c) signature for artillery firing like Hoffman on tube. d) improved conventional munitions. 3) night illumination round simulation. f) simulate delivery of nuclear strike. g) smoke simulation around artillery unit. h) direct fire simulation on tanks and personnel when overrun. i) TOW and LAW effects on artillery. j) mortars simulated. k) international (NATO) interaction for TES. l) demo, like interactive video, to learn MILES.

NCOs from the 1st of the 22nd Field Artillery, Pinder Barracks:

| | |
|---|---|
| SGT Doane Dennis | SGT Roger Nelson |
| SGT Epati Faamausilli | SGT Kevin Mitchell |

Comments:

It's important to be "humping rounds" in exercises involving the crews. Crews should experience how tiring it is to fire large numbers of rounds in combat.

A recoil simulator would be desirable.

The crews need some physical evidence downrange that a target was hit. But don't need to see the round hit unless it's direct fire.

Attrition in the target area using the controller gun is way off in timing; it takes too long for the controller to get to the area.

Almost all bursts are ground bursts.

A 14.5 caliber simulator is used in the actual artillery piece; very unrealistic as it is too easy to use.

Must use the real artillery piece, not a simulator.

Artillery units should be issued MILES to defend against attack, especially in the cavalry units.

ICM is a booby trap; DPICM is something different.

The Copperhead practice round gets rammed into the breech; this is good training.

There is a lot more live fire training in CONUS. They had only 300 live rounds for the battalion; in the US this would be for a battery. In Germany they live fire twice a year; in the US twice a month.

Artillery doesn't use MRAs; they use LTAs and Grafenwoehr.

If the FO can't talk to the FDC, the battery can't fire. EMI is practiced at Ft. Sill, but not in Germany.

FO to FDC is hardly ever voice; use digital data. Voice is used to talk to the mortars in the maneuver units.

The FO controls mortars, aircraft, helicopters.

CALFEX is done at Hohenfels; it's not much for artillery since it's all "canned".

One battalion in the 1st Armored Division is now switching over to MLRS.

They can't fire after dark, on Saturdays or Sundays. Only one "litter round" can be fired, i.e. one round from one tube in one battery; not good training.

They have the following needs: a) maneuver experience for shoot and scoot from counter battery. b) side arm (45 cal pistol) and shot gun MILES for artillery defense when attacked. c) logistics simulation (supply) for rounds. d) a round out of tube--could be plastic. 3) dry fire round simulator. f) air Support simulation and use ALO and LFO.

TES/5:122

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-132-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the Berlin Brigade, West Berlin, Germany, April 21, 1986

| | |
|---|---|
| 1LT Michael Beech | 1LT Maurice Dunne |
| 2LT Dennis Thompson | 1LT Dorick Bradley |
| 2LT Tucker Mansager | 2LT Kyle Keomalu |
| 1LT Edward McHale | 1LT Charles McCollum |
| 2LT Richard Heaton | 2LT Ronnie Pernell |
| 2LT Stephen Hagan | Mr. Francis Rothwell |

Comments:

Have trouble with MILES being activated by radio transmissions. In one exercise, 30 out of 100 M16 sets were malfunctioning in presence of large radars. Some have also been set off by the radios in jeeps.

Training grenades set off MILES transmitters, which hit nearby detectors, activating buzzers.

In the open, concussion has set off detectors.

Banging on the weapon can trigger the transmitter, setting off nearby detectors.

MILES lasers beams bounce around inside unpainted concrete rooms.

Nearby weapons are often set off when another weapon (rifle) is fired.

The MILES transmitters on M16s and M60s come loose, even to the point of losing the transmitters.

The MILES helmet detector belts come off too easily and have been lost.

Wearing the MILES man-worn harness under the rucksac is a real uncomfortable problem. Since the rucksac is dropped on engagement, it is best to wear MILES underneath.

Weight of the MILES transmitter on the end of the rifle barrel and the electronics/battery pack on the back of the helmets are big problems.

The screws on the battery pack covers are wearing out, resulting in the boxes coming open.

Batteries are often removed; main reason is MILES malfunction.

The Berlin TASC buys German batteries for 4.5 DM ($2.10) each. The German Duracells are good.

Lightning will trigger MILES.

Have problems when the harnesses get wet. The transmitter boxes take rain well.

MILES was used successfully in the Infantry Officers Basic Course (IOBC) in continuous rain.

MILES won't hit targets in the rain.

MILES TOW (ground mounted) works well.

MILES Viper used at Ft. Benning did not work; the resetting was the problem.

MILES is good in teaching that "John Wayne rushes" won't work.

MILES TOW can't be used with the new TOW night sight.

In MOUT, it is standard procedure to fire at targets that can't be seen; i.e., at a barbed wire location screened by smoke.

Claymore mines are important in MOUT defense; antitank mines are also used.

The M202 flash, firing four incendiary rockets into buildings, is often used; it should be simulated.

LAW will be used from the tops of buildings, firing into the soft tops of targets.

Booby traps are a big part of MOUT: widespread kills from C4, box bombs, Claymores, etc.

Communications by wire is the only thing that works in MOUT: long antennas are a giveaway, short antennas don't work from one building to the next, the 60-A radio doesn't work between buildings either.

Batteries are often removed from MILES, on orders, when a controller key can't be found.

Velcro must be taken off the vehicles in Berlin; appearance is paramount; the vehicles are even waxed for parades.

Wounding and mobility kills are used in current exercises. Present MILES capability (only near miss and kill) is sufficient, however; the controllers can handle the problem.

A grenade simulator is an important need. It must have "cookoff" capability as well as provision for being thrown back.

Grenade simulator: if its not expendable, it will only be thrown where it is known it can be recovered; definitely not realistic.

M21, M18, M16A1 mines are being used in Berlin. The most important thing on a mine simulator is how to set the fuse.

A simulated mine must be detectable with a metal detector.

The French have an antipersonnel mine simulator that smokes.

A simulator is needed for the M90 recoiless rifle, a good tool in MOUT.

Need a simulator for the M203 grenade launcher; this is very important.

In MOUT training, 2 or 3 companies typically attack 10-12 men defending a position. The whole exercise being monitored by two controllers. One controller should be provided for each squad, or for each 3-man clearing team.

The last ARTEP, in December 1985, was "heavily" monitored; 6 to 8 evaluators for a company-level attack. The ARTEP is mainly defense.

Tanks are used in MOUT only in overwatch or for clearing paths (move out, fire, move back).

There is nothing now to attrit troops behind a barricade which takes a hit from a tank main gun.

There are 560 MILES sets at TASC in Berlin. Of these, only 17 sets are for tanks and 9 sets are for APCs. There are only 17 tanks in Berlin, mainly for parades.

Must be able to place and remove a simulated minefield, including setting range cards, etc., all the steps of doing the real thing.

Need to know where you got hit, by some kind of marker, as a cue to play with medics; casualties will have a big impact.

Noise is an important part of realism, you must have it to know where to direct fire. Less noise wouldn't be satisfactory.

For training in the chemical environment, it would be nice to have something that made your eyes sting or your nose run. But it could never be used in Berlin.

When someone has to run very far, he will always break the seal of his mask under the chin.

Decontamination of vehicles is crucial. A driver must be required to use his M11 kit to decon both his vehicle and his radio.

The Army is using the Talissi Dragon Simulator in Berlin and like it for both its reliability and its gunnery training benefit.

The McDonnell Douglas Launch Effects Simulator (LES) is well liked, but not the LET which it is used with.

They now use "artillery simulators", hand thrown pyro.

For simulation of indirect fire, it is important to include white phosphorus, incoming smoke, and a way to adjust mortar fire.

If MILES could be used as the "standard of quality", it would be used much more often, i.e., as a gunnery trainer.

Berlin TASC personnel want to test new training equipment.

They could use a red light in or on the helmet for casualty indication.

They would use TES in cold weather.

The smoke from weapon blanks being fired in a room affects MILES RTCA.

It is difficult to get MILES web on; the front strap. Web harness snags on everything.

MILES has range problems; they use weapons at very close ranges.

Things get more beat up in MOUT because of concrete construction and what troops have to do.

MILES .50-cal MG doesn't get hits round for round. It works OK at 300-400 meters, but they use it at 200-300 meters.

They could use BB guns, pellet or stun gun in MOUT for more realism.

Comments regarding MILES cheating: a) bang on weapon to set off laser, b) squad cheats by blowing into MILES mike, c) 10% of soldiers have god key; they make by filing off regular "lost" key, d) add jumper in plug so they have continuous fire from laser.

They have the following smoke and fire simulation needs: a) burning buildings, b) free play in smoke in and out of buildings.

They have the following needs for M16 rifle: a) quieter MILES sound or noise suppressor for inside buildings, b) decrease MILES M16 weight, c) gunner qualification, d) use night sights, e) dry fire capability and dry fire on rifle zero box.

Misc. needs are: a) OPFOR mock vehicles; they could use VISMODS, b) simulation for support forces, c) nuclear effects simulation, d) to stop tank at 35-40 meters, e) battery for cold weather use, f) battle noise simulators.

Need simulation of other weapons: a) dismounted 50 cal, b) threat 9mm, c) shotgun, d) heavy munitions for demolition effects and cues, e) Squad Automatic Weapon (SAW) f) anti-handling devices, g) Stinger, h) HEAT, i) MILES grenade (they can't use training grenade in MOUT, j) MAX and MITS from LORAL for MOUT RTCA in buildings, k) artillery and mortar support.

TES/1:132

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-126-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the Berlin Brigade, West Berlin, Germany, April 21, 1986

| | |
|---|---|
| SSG Roy Hickey | SSG Elijah Jackson |
| SSG Milton Guzman | SSG Dennis Washington |
| SSG Ronald Jolly | SSG Michael Hines |

Comments:

Detector harness on the Kevlar helmet is a real problem.

Resurrection is unrealistic.

Can't hit anything with the M60 or .50-cal machine gun. There isn't a MILES laser shot for each blank; it's more like 1 for 3. Can't hold zero. Only reliable out to 300-400 meters.

There is interference with the Load Bearing Equipment (LBE) when putting on the MILES man-worn harness.

Counterfeiting keys is done to give unlimited ammo to Dragon and Viper.

Keys were conterfeited in the OPFOR at NTC.

"MILES is not taken seriously" in Berlin. It worked well in mechanized units, but not in the MOUT arena in Berlin.

In ARTEPS, players are resurrected so that eventually the OPFOR loses; this has caused players to lose respect for MILES.

The debris left in the M60 machine gun when firing blanks is very objectionable. Blanks "carbonized" the weapon; would prefer to use compressed gas to get a bang. It takes "a week" to clean an M60 after firing blanks so soldiers hesitate to fire it in training exercises.

Troops dread going to Doughboy City. It takes a week to clean it up after operating there 3 days.

They have spent 36 hours of a 48-hour exercise at Doughboy City filling, placing, emptying sandbags. Yet they know they won't be used if they fight in Berlin.

The Berlin Brigade trains four weeks out of the year at the German MOUT facility at Hammelburg. It is more realistic than Doughboy City. The troops like Hammelburg because they don't use sandbags there.

Need a mortar simulator to show rounds are fired properly; they have simulated fire into Doughboy City from 2 1/2 miles away.

They use "toe stoppers" antitank mine simulators mounted in a M21 mine; it just pops, no smoke.

Don't need size and weight simulation in mines; "it's the effects that count".

Need simulators for the M203 grenade launcher and the M90 recoiless rifle.

They have ATWESS; last used it 3 years ago.

Noise is "only for officers", it's the results that count; they liked the BB guns used in the 1960s.

Need to mark targets when they are hit; paint capsules would be good. Everything in MOUT is done at close range.

Laser ricochet and sympathetic firing inside buildings is a big problem.

"Guys get ticked off at MILES and take out their batteries".

"When you shoot a TC with your .50-cal, you can't hear his buzzer go off. How do you know that you hit him? Anyway, he probably has his battery out".

Suggest using hit lights on people, because in MOUT you will know if you hit people. It would also make cheating harder to do.

The French have a hand grenade simulator that works well; it has a big bang and throws out a white powder over 15-20 feet.

HC smoke is bad stuff.

Should use VISMOD mockups instead of real vehicles.

TBI in Baltimore makes OPFOR VISMODS.

Attacking vehicles are used in MOUT only during ARTEPS, about 2 weeks out of the year.

The Squad Automatic Weapon (SAW) is an outstanding MOUT weapon.

Would like to use UZIs instead of M16s; the 3-round burst is bad news for MOUT.

Need to simulate the M202 flash.

B-Company of the Berlin Brigade has few vehicles; they say they are one of the few "straight leg" outfits still in the Army.

They now have only four men in a non-mechanized squad.

Use 4.2-inch and 81mm mortars in tracked vehicles.

In cold weather they have dead batteries.

They have the following needs for TES: a) correct the M16 rifle firing errors: MILES goes off automatically and is too loud in MOUT rooms; the M16 rifle balance and weight, b) artillery simulation, c) be able to simulate stopping tanks at 35 to 40 meters, d) burning buildings.

TES/1:126

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-131-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 7th Army Training Command, Grafenwoehr, Germany, April 22, 1986.

MAJ Flavin
CPT Williams

Comments:

NTC - Europe will be called the Combat Maneuver Training Complex (CMTC)

CMTC will be at Hohenfels, 40,000 acres (about half the NTC maneuver area), will have a MOUT facility.

A mechanized battalion from Schweinfurt, equipped with Bradleys, will be the CMTC OPFOR. Will be there by 1990.

Expect to have a CMTC computer work station by December 1986; will use NTC software which has been influenced by CMTC requirements.

Evaluating Position Location (PL) systems for CMTC now.

VISMODs for the OPFOR Bradleys will be a problem because of the height of the Bradley.

Expect CMTC to handle 56 battalions a year, with a maximum of 256 days a year availability. Each brigade would thus get 16 days. Will be able to overlap brigades, with only one maneuvering at a time. Thus each battalion would be in a 4-day instrumented exercise.

The 56 battalions will be armored cavalry squadrons and armor task forces.

Will be bringing additional MILES to Germany for CMTC in 1988.

Want Air Force aircraft instrumented for CMTC.

Need helicopters instrumented such that they don't have to land to see if they have been killed.

CMTC will use something like the Loral Multiple Independent Transmitter System (MITS) to make combat support vehicles targets and their .50-cal machine guns instrument weapons.

In Germany, there is a terrible dust problem on tank trails in the summer.

Mud gets on the detectors.

Brush rips off the MILES.

Need shorter operating range for MILES TOW, with shorter hold-on time; use ranges as short as 500 meters.

Expect to use Bradley Precision Gunnery System (PGS) and Tank Weapon Gunnery Simulation System (TWGSS).

Winter operations work down to -30°F; need protected mounting to prevent sliding down slopes into trees.

"Gunnery and tactics are like locked fingers"; CMTC must have capability of simulating precision gunnery.

Aircraft at CMTC will probably be USAF A10s, British and German fast-movers.

CMTC will have a skeleton crew of 10 to 15 full time controllers.

There are four line companies plus an antitank company per battalion, three battalions per brigade.

At CMTC, one battalion will be maneuvering while the others, without OPFOR but with MILES, will be training in squad-level and larger exercises.

Hope to develop a method of delivering a package of CMTC lessons learned to the units.

Also mentioned:

ARTBASS
ABKA (German?)

The Future will have helicopters in air-to-air combat.

Need to interplay TES with the British simulation systems.

They have problems finding a place to use MILES; Hohenfels is one of the few.

Need to be able to have smoke simulation and use TES in obscurants.

MILES good for squad versus a platoon in a Local Training Area (LTA).

Artillery doesn't use MILES; they need to have counter battery fire and infiltration, and overrun of positions. They never train these, but can expect it in combat.

Need to have TES for air defense; need to be able to lead aircraft.

New TES artillery needs: hump rounds and logistics, Copperhead type of rounds and other improved munitions.

Need a mobile, independent TES target system; like "Dial-a-MILES".

They will need future TES to be compatible with the new fire control systems.

TES/1:131

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-221-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep

SUBJECT: Tactical Engagement Simulation Meeting with the 7th Army Training Command OPFOR, Grafenwoehr, Germany, April 22, 1986

1LT Lori Roepke, Military Intelligence Unit

Comments:

Will do company-sized OPFOR against a platoon. Need to adapt MILES to weapons on real Soviet armored vehicles: main guns, machine guns, Sagger and Sapper ATGMs, antiaircraft guns:

They have: T54, T55, T62, MTLB, BMP (with Sagger), BTR60, and GAZ69 (with AT-1 Snapper).

Need to simulate both vehicular and dismounted ATGMs.

Would especially like to have MILES for small arms, because a lot of these, like AK47s, are available in most units. The AK47 has a greater range than the M16 and this should be played.

Have blank ammo for the Soviet small arms.

TES/1:221

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-128-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the OPFOR at the National Training Center, Ft. Irwin, CA, May 6, 1986

SFC Harry Zilkan
1SG Larry Blaine
1SG Hubert Key

Comments:

MILES works well overall.

Detector covers coming off the MWLD harnesses is a problem.

Too many false kills.

The Sheridan is an excellent desert vehicle. Don't think the Bradley would be as good except for the gun platform. Replacement sprockets are a problem with the Sheridan.

Any training vehicle for NTC will have to be tracked, for high speed attack.

Don't get enough hits with MILES against tanks.

Don't get enough kills of dismounted troops.

The MILES helmet unit and body harness are terrible to wear. The harnesses are not safe in vehicles. The battery box on the back of the harness is a "no go".

Even if MILES buzzers can't be heard, you can always tell if you hit someone by the actions taken: digging out his key, throwing down his helmet, etc.

Casualty cards leave a lot to be desired, mainly because it takes controllers too long to get to the scene.

OPFOR uses MILES Dragon (range of 1km) to simulate Sagger (range of 3km); they should be using MILES TOW.

When the OPFOR is whipped by good gunnery, it is MILES gunnery, not real gunnery. It is important to teach good real gunnery.

"FASCAM is a joke". It takes out too many vehicles. Present NTC doctrine says its OK to drive through at 2 mph. FASCAM mines need to be replicated so something can be seen on the ground.

Mobility kills are now simulated using controllers, but only on the BLUFOR. Mobility kills are important because crews will fight to the end.

The check-off system that's part of MILES TOW is good.

MILES battery boxes come open, terminals corrode, springs loosen.

Electronic warfare is played on both sides now. Don't need new development, just more jammers.

NTC OPFOR modifies basic MILES kits to fit their vehicles. They use laser filters to modify weapon characteristics. BMP kits are modified to fit the BRDM. Linking Sagger kits to the BMP was more of a problem.
Need to simulate the Soviet T80. This includes greater laser range, harder to kill, but most importantly, a stabilized gun platform for shoot-on-the-move. This would require using a VISMOD on either an M1 or a Bradley.

The upgrading of MILES for OPFOR weapons is not keeping up with that for new US weapons, such as Bradley and M1.

Hit smoke is a good idea; it is used in live fire. The smoke may be a problem with some of the plastics on the new vehicles.

More use should be made of the standard-issue Load Bearing Equipment (LBE) is designing new TES man-worn harnesses.

The OPFOR at NTC boresights and zeros every night. This may mean that some batteries need only last 24 hours.

The OPFOR Uses plastic VISMOD Soviet helmets. This means that if there were a special training helmet in the future there might have to be more than one configuration.

Detectors on the helmet are a must; marksmanship is taught.

Future systems need to be able to shoot through foliage and smoke.

Don't need to know the location of hits or wounding.

Should add "wounded" to the present attrition of "near miss" and "killed".

Today's soldier appreciates sophistication and technology.

The OPFOR uses XM44 image intensifiers for night sights. Also use PBX5 goggles, but only one or two per company.

Involving the loader as a member of the tank crew is important.

MILES TOW is good because rounds need to be loaded. (??)

It is both practical and desirable to train units to replicate Soviet tactics.

For simulation of mines, tilt rods need to be implemented.

Soviets don't bury mines. They are laid on top of the ground with every fifth one having an antihandling device.

NTC needs something to simulate the Soviet 40 mines/minute automatic mine layers.

Minefields can be breached by the OPFOR in about 5 minutes using such techniques as grappling hooks. If these areas aren't covered, they're not effective.

Satchel charges are an effective infantry weapon against armor and they should be simulated.

A hand grenade simulator is needed, but safety must be observed.

Fewer controllers and more fire markers are needed.

Crew kills are done by controllers, but this may not be a cost effective item.

There is little cheating by the OPFOR; they don't want to give the BLUFOR any excuse to say why they lost.

MILES keys should be eliminated.

Should have the capability to resurrect vehicles from Central.

Maintenance at NTC is only remove and replace; repair is done somewhere else. (Note: This is incorrect. There is a CLS facility at Ft. Irwin). MILES isn't too complicated for local, Army-controlled maintenance.

Need to instrument, so as to involve, the fastmovers. Have ground-to-air now; need air-to-air.

The ZSU systems work OK, it's the aircraft that need to be instrumented.

Need the firer's ID on the laser beam to establish pairing: This is very important. The current system of sectoring, by the computer in Central, is inadequate.

The MILES key is too slow in a fire fight for realism.

The dismounted infantry need to have casualty differences for different body sections.

Individuals are prone to cheat by having high tolerance for buzzer noise irritation.

For medical play they need: a) Simulation for casualty self aid, b) BLUFOR evacuation (the OPFOR at NTC does not need to play), c) wounded need to know where hit, d) wounded need to be able to continue to fight.

The NTC OPFOR is effective at using 200 to 250 troops for simulating an 800 man rifle regiment. They need capability for using variable strengths in OPFOR simulation.

Need simulation of thermal and starlight sights.

Need separate weapon codes for vehicle, dismounted, and aircraft TOWs.

Red Thrust team from Ft. Hood, Texas gives MILES courses: three days for a platoon; one week for Company and two weeks for Battalion exercises. They do a good job with this amount of effort.

NBC needs are: a) affect a 10 km by 10 km area, b) spontaneous casualty assessment, c) persistent and non-persistent agents, d) only instrument the mask (the garment does not need instrumentation, they are in MOPP by command), e) tactical nuclear simulation, f) decontamination simulation.

For simulation of mines they need: a) AP device to send out automatic casualty assessment, b) automatic capability to lay mines without resources for OPFOR.

They need delivery of artillery fire to be accomplished even when it is not on target; it gives away enemy position, etc., if seen by forces.

They use Article 15 at NTC for cheating by MILES equipment modification.

Need better test set capability to determine which box is bad; could use a self check; now it is a trial and error process to locate bad element.

For After Action Reviews they need battle damage assessment data; firing weapon identification and time of engagement.

For radio communication simulation they need: a) radio jamming and direction finding, b) automatic scramble and back and forth English and Russian, c) to have all transmissions which are too long pay penalty (the TOC talks too much).

TES/1:128

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-220-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 9th Infantry Division, Ft. Lewis, Washington, May 7, 1986

CPT Rounds

Comments:

When used properly, with adequate training, the MILES for TOW 2 works.

The present MILES TOW will not work with the TOW night sight. This capability is needed; the 9th ID will fight mainly at night.

Now using MILES M113 kits to instrument HMMWVs, but they are not satisfactory due to the higher vulnerablility of the HMMWV.

Since the 9th ID is losing its M113s to HMMWVs, it's also losing its M113 MILES kits. But there is no replacement kit for the HMMWV.

The primary weapons for the 9th ID are the TOW and the MK19 40mm machine gun.

The MK19 40mm machine gun is primarily an area effects weapon for use on the HMMWV; it has a 5 meter burst radius:

The 9th ID is considered a motorized division, the only one in the Army.

The HMMWV will be a weapons platform, armed with the TOW.

In January 1987, the MK19 will be tested, with units of the 9th ID, at Ft. Hood. Schwartz Electro Optics is building a MK19 simulation system to be used in these tests.

The 9th ID will be going to 120mm mortars.

The 9th ID has done a company-level exercise at NTC using the HMMWV.

9th ID priorities for future TES:

1. Simulation of the MK19
2. Simulation for night firing of TOW
3. Simulation of towed 155mm artillery in combined arms exercises.

For a motorized division, the position for engaging the enemy will look very much the same for both offense and defense.

For breeching mines, need something that simulates the characteristics (shape, weight, trip mechanism, etc.) of threat mines. (Note: threat mines).

Will use Stinger on the HMMWV and towed Vulcan for air defense.

Gunnery training devices should be separate development; gunnery is an issue different from tactics or maneuvering.

TES should be used to train leaders; gunners can be trained in many other ways.

If TES can't simulate exactly the kill probability of actual weapons, then it should be biased to be less effective than the real weapon.

It's important to instrument vehicles that play combat sevice support in exercises.

The 9th ID does not expect to operate in the jungle or MOUT environments.

Attrition by wounding, and the requirement for subsequent medical action and evacuation, would be very desirable.

There is positive training value in teaching US troops how to fight like the OPFOR, having them use OPFOR weapons and tactics in force-on-force exercises.

Brigade-level field training exercises can be done at Ft. Lewis, but company-level is more realistic.

Video films would be very desirable for AARs; standoff video would be more practical than gun camera video.

Addition of graphics displays and logged data (such as round counts, which might minimize cheating) would be desirable.

In any exercise, you need a mediator. If he had less equipment to carry, he could do a better job.

AARs should be held within 24 hours. As an example, if a battalion-level exercise ends in the evening, then the AAR should be held by the next afternoon. For company-level exercises, the review should be going on continuously throughout the exercise, during breaks for example.

Batteries in TES should be eliminated or used only when no other power source is available.

It would be a good idea to have something automatic to require a driver, especially, to take same action when he is attrited.

Locations of hits on the body is of no interest.

Need TES for fire-and-forget weapons.

Need simulation of 107 and 120mm mortars including movement and control by FOs.

Need simulation for dismounted air defense weapons, and multiple codes so that weapon can be identified later.

Need TES for FASCAM.

TES/5:220

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-212-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 214th Attack Helicopter Battalion, 9th Infantry Division, Ft. Lewis, Washington, May 7, 1986

CPT Michael Courts
CW3 Brent Cowley
CW2 Fred Peacock
LTC Lay

Comments:

Attachment of the MILES system on the OH-58 is quick.

Position of the kill indicator box in the OH-58 is very bad, it robs the crew's field of view. The box has only 2 lights and a switch; it should be a lot smaller.

Need more codes for types of kills. Need different kill codes for airborne and ground TOW.

Would like to know type of engagement in real time. The 2-digit display should be moved from the back seat to the cockpit. An alphanumeric code would be better than just numbers.

The target vulnerability needs to be variable so credit can be given for use of counter-weapon equipment, such as radar and IR jammers, when they are turned on.

The detector belts are OK. When installed, speed is limited to 100 knots, but this wouldn't be exceeded anyway.

When EW jamming is done by MI units, emergency radio transmissions may be compromised.

Batteries last several days in the OH-58, but only one day in a Cobra. Would prefer working off helicopter power; there is a "non-essential bus" that could be used for this purpose.

The OH-58D will not have room for MILES equipment in the back seat.

The hit smoke works well on the helicopters; would like something similar for tanks.

There is no need for quick re-keying of the MILES system.

The MILES simulation of TOW is marginal.

TOW can be fired around obstacles and when coming up out of masking in real life; MILES TOW can't.

A 12-second TOW engagement is rare and unrealistic; 18 seconds would be better. A variable time for TOW engagement would probably not be worth the cost.

Need simulation of the rockets on Cobra when launched in the indirect fire mode. Multiple fire rockets, which are coming, will be very lethal and must be simulated.

AWESS is a problem. It must be disarmed before refueling; it's in short supply and MILES can't be fired without it.

The MILES-Cobra system is too heavy: 360 pounds. But it does take the place of the weight of live ammo.

Cheating is a real problem at the unit level at Ft. Lewis, but not at NTC.

They have 150-200 users sharing 39 MILES systems.

The MILES shipping containers are well done; there's an opening for each piece of the system.

MILES can be drawn at NTC but they prefer to put on their own and fly down with it on.

An excellent feature of the MILES-Cobra is that it won't fire unless all the weapon system switches are in the right positions for firing.

Rockets and cannons are walked in on the targets; MILES doesn't do this.

MILES doesn't replicate the AADS air data system.

Can't kill artillery at NTC. This would be done by rockets in indirect fire. Soviet artillery is very vulnerable to helicopter weapons.

Have received false kills from microwaves.

MILES-Stinger has been used. It's a very effective killer. Maybe it's too effective since available countermeasures aren't taken into account.

What was thought to be reliability problems with MILES turned out in many cases to be operator problems.

MILES should be made easier to install.

Boresighting MILES is more difficult than with the real TOW.

MILES-TOW doesn't seem to give enough kills versus real TOW.

The MILES TOW must be boresighted on each return to the FARRP; it takes about 1 hour.

Controllers attrit too many helicopters from artillery.

At NTC, too many things are done in too short a time: 4-5 hour exercise, AAR, move to next assignment, etc.

At NTC, exercises end too soon. OPFOR has a long engagement with BLUFOR defenders, finally get a company through, controllers call exercise over. Air cavalry had been waiting for just this circumstance to attack.

Air cavalry fights either forward or in the rear, not in the main battle area where they are too vulnerable.

MILES-AGES is impressive.

The MILES on the OH-58 has a strap that covers the wire cutter; this is very bad.

The Aircraft Kill Indicator (AKI) green smoke corrodes the smoker canister holder. (Note: only the M18 smoke canister is to be used).

There are four types of TSUs:

Plain TSU - Optics only
MILES TSU - Plain with MILES laser added
Laser TSU - Plain with laser rangefinder added
C-Night - All of the above

The laser rangefinder is used primarily for the rockets.

Exchanging the MILES laser with the laser rangefinder in a TSU is a depot level job. In the field, the whole TSU is exchanged.

During war, training is still done; but imbedded training systems must have no possibility of degrading combat capability.

Maximum tolerable weight penalty for permanently installed TES equipment on a helicopter would be 50 - 75 pounds.

TES detectors, as an adjunct in combat, could indicate aircraft being lased, type of lasing, even work with other Aircraft Survivability Equipment (ASE) to defeat the enemy designator.

Other battalions at Ft. Lewis do not want to take the time to use MILES: it would take about a week to train to use MILES.

Hellfire must be simulated or the AH-64 won't be effective.

TES is needed for Air Force A10s; they are more important than F14s, F16s, etc.

Mobility kills are important. Non-movers that can still shoot must be avoided in battle.

Damage, without a complete kill, would add to realism.

It's not important to have to simulate the time in the FARRP.

No interest in intervisibility measurement.

At NTC, controllers are poor quality; they seem to be the losers.

Controllers are trained only as part of New Equipment Training (NET).

Order of priority for AAR data is:

1. Video
2. Graphics
3. Logged data (such as ammo expenditures, fire sequences)

OH-58D will be armed with Stinger. Air-to-air is an existing tactic for present helicopter, i.e. the Cobra and Apache.

Lack of a simulated weapon firing flash is not a problem. Except for tracers, modern weapons don't have a flash.

The Cobra doesn't have thermal sights, but the Apache will. (Note: Cobras with C-Night will have thermal sights?)

TES/2:212

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-217-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 2nd Battalion, 77th Armor Regiment, 9th Infantry Division, Ft. Lewis, Washington, May 8, 1986.

CPT James Boling
1LT Richard Atkinson
2LT Jeffrey Davidson
SFC Stephen Peoples

Comments:

When you turn off all the aids in an M60A3 to use MILES, you're back to an M60A1.

When using MILES, the TC doesn't have to assess the lays, over, under, etc.; it would be important to have a BOT indication to do this.

Don't get enough hits with MILES versus real combat.

There is marginal hit capability beyond 1600 meters. Detectors should be mounted higher, have better placement.

The ATWESS signature is not large enough for some weapons. Firing signatures are absolutely essential; you must know what is shooting at you.

Hoffman smoke is OK for daytime, but the flash is not big enough for night.

Doctrine today does not allow the separation of tactics from gunnery. Training is 60% gunnery to 40% maneuver; and only 25% of maneuver training is force-on-force.

As far as placement of detectors is concerned, the current doctrine is to aim for the center of exposed mass, not to look for vulnerable spots.

Mobility kills aren't important.

Don't need to separate hull hits from turret hits, etc.

MILES was used at Advanced Officers Basic (AOB) to train gunnery.

Would like to be able to shoot at moving targets.

Would like shootback targets.

Would like to have hit smoke on targets, as well as round impact flash.

The TC and loader are the only ones who need to be instrumented when indirect fire is used.

Having wounded as a type of attrition is important.

Need to have for gunnery: the loader select and load rounds, recoil, adjustment of fire, shoot-back targets.

TES/5:217

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-216-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 2nd Battalion, 1st Infantry Regiment, 9th Infantry Division, Ft. Lewis, Washington, May 8, 1986

SSG John Richardson
SSG Robert Perry
SSG Roger Thill
SSG Robert Canarios
SGT Edward Gouldburn

Comments:

Can't columate the MILES-TOW sight with the TOW 2 night sight.

There is a new TOW sight under development that can be used from the cab of the HMMWV.

MILES torso harnesses don't have enough adjustment; can't be made to fit smaller soldiers.

MILES helmet harness is too heavy, off balance, doesn't have enough velcro adjustment to catch adequately.

They use the torso harness on top of a rucksac for a Fast Attack Vehicle (FAV) (dunebuggy) hit sensor.

Batteries are a big reliability problem.

Too many instances of the MILES going off on its own.

Don't feel that bushes provide protection from MILES.

Controllers, especially ones from other units, tend to over control. Don't feel there should be a need for controllers with MILES.

Cheating is a big problem and it is important to prevent it. Cheating may be the only reason that controllers are needed.

The buzzer is an adequate kill indicator.

Weight on the end of the rifle and on the helmet is a problem.

Weight on the torso harness isn't a problem if the harness can be adjusted to fit well.

9th ID doesn't carry rucksacs; they leave them in the vehicles.

Need detectors on the FAVs as well as on the soldiers.

Batteries usually last a week, but many of the exercises at Yakima last more than a week.

Have trained with MILES in Denmark at -40°F. The MILES in the tracked vehicles worked, but the batteries in the MWLDs didn't function.

MILES works OK with MOPP gear.

Would like to improve MILES TOW so it can replace the M70 target. Need to know where a TOW round went when it misses the target.

A company will get maybe three real TOW rounds. The highest of 18 people qualifying gets to fire one round.

The noise of blanks requires ear protection.

Would like to have more MILES available; now have to put in for it 3-6 months in advance.

"If its realistic, a soldier will start thinking".

Wounding type of attrition is important.

Chemical simulants and decon training aids are needed.

Did a survey with the T1 trainer. It worked great, the soldiers liked it.

Hand grenade simulators are a great idea, but they won't be used if someone has to sign for them.

Need a simulator for the MK19.

Very seldom use mines. Set hasty minefields with M16s; each FAV carries two, as well as Claymores.

Need to be able to arm and disarm simulated mines.

They pick up mines they don't use.

FAVs don't breach; they go around.

Use a lot of smoke, from smoke grenades and 4.2 inch mortars.

Need to be able to shoot through smoke as can be done with the TOW 2 thermal sight.

Simulator or incoming artillery is desirable; 9th ID tactic is to immediately go the other way.

Have no weapons to engage aircraft, but need to train evading aircraft.

Unit has only been to NTC once, won't go back until November 1987, if then.

TES/5:216

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-219-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the G3, I Corps, Ft. Lewis, Washington, May 8, 1986

MAJ Grubb
SGT Welker

Comments:

A problem with laser engagement systems: concealment is cover, but much of it would be shredded by an M60 machine gun.

Don't get enough attrition in terrain covered by foliage to generate the fear of getting killed.

The biggest killer on an ARTEP battlefield is the controller.

Captains, E6s, E7s, E8s, make good controllers.

Controllers are an asset; they are always needed.

Don't get enough kills with MILES - Viper.

The big advantage of MILES is that you don't need a controller behind every soldier.

MILES is a good ARTEP vehicle if it is preceded by proper training.

Soldiers participate with their detectors turned off to avoid the embarrassment of admitting they've been killed.

Having problems with batteries due to both heat and cold; use up 5000 batteries a month.

They need a simulator for a "bunker buster".

The M60 tank and M113 APC MILES kits are installed on jeeps for use as targets.

It is important to be able to get the complete battalion task force to play so as to have a complete combined arms weapon compliment for this level. Don't train above the battalion level now.

Use TES for weapon qualification: absolutely not. This must be done with the real thing.

Need minimum range down to 5-15 feet for close combat.

Need to be able to set up and do TES training in about a half day.

A TES hand grenade would be desirable.

Automatic zeroing and boresighting of TES would be good.

Need something like the MILES Mobile Independent Transmitter System (MITS) so that a wide assortment of weapons and targets (such as bunkers) can be engaged. This would also be used with command center, supply, combat service support, etc.

The "Polish cannon", a noise maker, is fantastic when you can get it working.

Need to reinforce the marksmanship aspect of aimed fire.

No interest in wounding type of casualty assessment. Present method, using casualty cards and controllers, is better. Involving medical problems and evacuation of the wounded is an important part of training, but it is only done on a limited basis.

Simulating Soviet weapons and using Soviet tactics should have a low priority.

Simulation of mines should have the following priority:

1. Claymores
2. Antitank
3. Antipersonnel

BOI for Claymores should be at least 5, as many as 30, per company. They are an important defensive weapon.

Best simulator would be one which simulated both size and weight, but was a throwaway.

The aquisition hassles for TES must be minimized.

For FASCAM, if you're going to simulate putting it out, you've got to have a method to simulate taking it away (self destruct).

Need to have minefield breaching in TES.

Need to have TES devices for MOUT.

TES/5:219

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-211-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep

SUBJECT: Tactical Engagement Simulation Meeting with CDEC, Ft. Ord, California, May 9, 1986

Mr. Gary Love

Comments:

British have a MOUT training area in Berlin called Rhuleben City.

British are using a special Centronics (UK manufacture) system in buildings along with SIMFIRE. The Centronics system incorporates an ultrasonic sensor to fire the laser before recoil.

Windows in Rhuleben City are instrumented as tank targets.

British use tanks and APCs in both the MOUT offense and defense. Tanks are very effective at clearing and blowing up buildings. They follow Soviet doctrine: roll fast; U.S. doctrine is slow approach, clear each building.

The British system kills the player, not the weapon.

The player has to lie on his back in order to silence a loud casualty assessment buzzer.

Use grenades, booby traps, "mouse holes" (wire mines) at Rhuleben City.

British aren't as concerned about safety as we are.

CDEC definition of types of engagements (these are important to TES):

1. Static - small arms, mines, etc.
2. Low Dynamics - indirect fire, chemical weapons, guided missiles, seekers, etc.
3. High Dynamics - air combat, air defense. (air to ground and ground to air)

| | Engagement Envelope | Casualty Assessment |
|---|---|---|
| Static | Fixed cone, fixed footprint | $P_k$ lookup tables |
| Low Dynamics | Variable cone, variable footprint | $P_k$ lookup tables |
| High Dynamics | Lethal volume, in time and space | Flyout models |

(It appears, at first glance, that MILES technology acts in type 1 and type 2)

CDEC may be buying ten Saab BT-41 systems. The CEDC methodology chief, Mr. West, is from Ft. Knox, has seen BT-41 demonstrated and wants to use it.

Saab BT-41 is better than video systems for gunnery training.

JPL needs to look at British AAR's for Rhuleben City exercises for the TES BTA. We should talk to the British about their technology.

TES/2:211

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-210-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep

SUBJECT: Tactical Engagement Simulation Meeting at CDEC, Ft. Hunter-Liggett, California, May 9, 1986.

| | |
|---|---|
| Mr. Robert Church | 1LT David Freeman |
| Mr. Bruce Coons | Dr. M. Elliott |
| Mr. Spike Kenn | Mr. Mike Tedeschi |

Comments:

Using Direct Fire Simulation (DFS) system for up to 512 players.

Have some MILES systems modified for use with DFS laser codes.

At CDEC, not interested in the engagement system doing casualty assessment. Main interest is in weapon/target pairing, time and place. At CDEC, casualty assessment is done in the central computer.

The firer's ID is essential in testing; it may not be as important in training.

Looking at using reflected laser energy to detect hits on tracks, with detectors from MILES, DFS, or Laser Designator Detector (LDD).

May have new electronic boxes, called Universal Logic Modules (ULMs) in time for upcoming tests with the OH-58D. The RMS-B unit will be used in conjunction with the VLM and rust be supplied with power.

May use altitude data from the aircraft 1553 bus, radar, or barometric altimeters for altitude. RMS is not much good for altitude because the A-Stations at Hunter-Liggett are all pretty much in the same plane.

Have used laser rangefinders in tests by designating the test area a "live fire test area". Everybody, including US Forest Service employees in fire towers, wears goggles.

Used X,Y,Z pointing data from the weapon during the tests of the Sergeant York system.

Have used Radio Direction Finding (RDF), with shaft position encoders on turrets, to measure hull and weapon pointing angles for up to 40 players. It was a real hassle and probably only gave reliable data to $\pm$45 degrees and lots of data to reduce.

Use the DFS, with flyout modeling, for TOW.

Use non-eye-safe scanning laser system to simulate the effect of area weapons.

Trying to adapt some 24 GHz police radar equipment for a K-band weapon pairing system that will penetrate some smoke and simulate some radar-controlled air defense systems.

CDEC has done a mine simulator study using a K-band 24.5 GHz 40 milliwatt commercial transmitter. It is set off by an actual mine initiator, radiates an RF signal which is picked up by the tank or other target. System has an elliptical sensitivity area of about 6 X 9 feet, uses a scatterable mine training device with a Picatinny Arsenal fuze. Total cost about $300.

Will also try an RF link between the turret and the hull.

The K-band mine simulator includes a recovery aid: a 24-hour audible and visible recovery signal which is set off by a timing device.

CDEC had a chemical mask but it didn't work well due to the physiological difference between soldiers, i.e. size, effects of physical activity, etc. The test results were sent to the Chemical School.

Don't use electronic jamming because of their proximity to the coast. They play it sometimes only by simulation.

One problem with using jamming equipment is that it also affects the TES instrumentation.

Local area jammers which attach to the front end of radios have been proposed and may be feasible.

Intervisibility instrumentation has been under development for eight or nine years with no measurable success. The Engagement Line of Sight (ELOS) system, developed for the Att-1 tests with 25 players, doesn't work very well. It's L-band and blocked by foliage.

The ELOS system is only accurate about 60% of the time: too many false yes's and too many false no's.

Future weapons which must be simulated are FOG-M and laser designators.

The obscuration pairing effort is "dying on the vine". Includes:

1. Harry Diamond Lab 95 GHz MMW system.
2. NVL IR ($CO_2$) laser fog oil penetrator.
3. Schwartz Electro Optics system study.

Need TES for the fire-and-forget weapons.

Need to have laser designator lock.

Need to know the misses as well as the hits with both the weapon and the target identified.

MILES and video tape work well together to verify engagement data.

They don't have a need for Claymore mine.

TES/2:210

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-214-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep

SUBJECT: Tactical Engagement Simulation Meeting at Ft. Bliss, Texas, May 13, 1986

| | |
|---|---|
| Mr. Paul Hermann | LTC Murray |
| Mr. J.W. Hendley | Mr. Dick Pfetef |
| Mr. Bob Laubenstein | CW4 Barker |
| SGT Santiago | Mr. Norman Chapman |

Comments:

The Hawk TAS has a television for surveillance, it visually interconnects video with radar. Video good out to 25km on a clear day.

Ft. Bliss is the proponent for drones, RPVs, etc. to use as shoot-back targets at NTC and elsewhere; use may require an instrumented range.

Use MILES with Vulcan, Chapparal, Stinger, OH-58, UH-1 and Cobra.

Cheating is easy: filing MILES keys and shorting out the console after taking out screws and removing the cover. (Latter was fixed by drilling out screw heads and epoxying the holes). People even make up their own MILES cables.

Keys need to be designed out, redesigned, or permanently attached to the device.

If buttons on controller gun aren't keyed in the correct sequence the end result will be a reset (reload), not a kill.

Only the MWLD torso harness has buzzer actuation when the battery is replaced.

The kill effectiveness of MILES-AGES is good; it's the same as the real weapon.

MILES Stinger and Chapparal operations are just like the real weapon. Vulcan is not: no ranging, must use the manual mode against the ground targets; very negative training.

Must boresight each time the weapon is moved. Doing this with MILES is good, positive training to boresight often.

It's easy to mount or remount MILES - 15 or 20 minutes.

MILES - Stinger does not simulate the battery pack of the real Stinger or the criticality of correct hookup of the battery pack.

MILES - Stinger does not simulate the Identification Friend or Foe (IFF) system; this is very important to simulate.

Sander Associates makes a Vulcan simulator, maybe only a gunnery trainer, that is more realistic than MILES.

They don't have any realistic targets. They mostly shoot at fixed targets, sometimes targets mounted on APCs. Use the Multi-Range Alignment Device (MRAD). Almost never shoot at helicopters or fast movers.

The big training void with air defense is on the gunnery range: lack of realistic targets, safety constraints when using live ammo.

They have no targets that simulate incoming attacking aircraft (a downed target might fall on the weapon).

The flash and bang are important for a gun system, but not for a missile system. Using blank ammunition is too expensive.

From the aircraft standpoint, tracers are important, more so than gun flash.

MILES is hard to get, partly because it's not type classified and is managed by TASC, not the units.

MILES for Stinger and Chapparal is negative training in that superelevation is disengaged and the operator doesn't have to aquire the target after launch.

Stinger is the important weapon of the future. Doctrine will be the Forward Area Air Defense Strategy (FAADS).

MILES Stinger and the Tracking Head Trainer should be (may have been) combined. The Stinger Launch Simulator (STILS) isn't liked and probably won't be used.

The AWESS gun simulator will use compressed air for the bang signature.

Units ought to have their own MILES AGES, not TASC, since there is only one air defense battalion per division and they don't have to share.

A MILES TOW cable can be plugged into the real TOW Missile Guidance System (MGS); when power is turned on, the MILES TOW electronics will burn up.

The MILES System Test Set (MSTS), which replaces the M144 test set, is much too complicated for soldiers to use.

The M144 test set is only used to check batteries.

Tankers (3) and TOW gunners (2) have yellow keys with no place to put them except their pockets.

There is $14M worth of MILES in the Ft. Bliss TASC that is not being properly utilized due to the lack of just two more support people and a vehicle.

A big problem with MILES is that no commanders are interested in any training related to the MILES itself. This includes installation, operation, and troubleshooting of MILES. There are ample instruction manuals but nobody uses them.

Some MILES system containers weigh almost 200 pounds.

The MILES Bradley TOW sets at Ft. Bliss have been modified; a reinforcing gusset has been added to the tube.

TES/2:214

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-215-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at the Army Combined Arms Center, Ft. Leavenworth, Kansas, May 14, 1986.

CPT Bullock
CPT Hall
MAJ Snow
LTC Langston

Comments:

Air Land Battle 2000 doctrine is now obsolete. The latest concept is now Army 21.

Army 21 is a follow-on to the Army of Excellence (AOE). The AOE force structure will be a transition from what there is now: Division 86. Army 21 is really for the year 2015 era.

In Army 21, a battalion may be fighting like a brigade does today. It will be independent operations at a lower unit.

Army 21 will drive technology as well as doctrine.

There is also an Army 95.

The AOE recognized the un-achievability of Air Land Battle 2000.

The distinction between direct and indirect fire may be becoming less and less due to the introduction of smart weapons.

Advanced weapons will seem a lot less like weapons, i.e., no humping rounds, no smell of cordite.

Fear and loneliness are important parameters of combat.

TES must include gunnery and realistic weapon effects.

Smart weapons will be used at long standoff distances, 10 km or more. Such long distances will result in less movement and high speed maneuvering on the battlefield than is required today with short range line-of-sight weapons.

The real drain in the battlefield of long range weapons will be in the command and control structure.

| | |
|---|---|
| LTC Garrison | CAC Combat Developments |
| CPT Forrester | Concepts (AOE, Army 95) |
| MAJ Goodloe | Concepts (Army 21) |

Comments:

There is a General Officers Steering Committee looking in to new ways to use mines. The Engineering School is the sponsor.

The Forward Area Air Defense System (FAADS) is another new area. It may involve field artillery, helicopters, the Bradley, etc.

Submunitions may be used to destroy helicopters from above.

The weapons of the year 2000 are known now; they should now be on the drawing boards.

Command and control must include not only the combatants, but also combat support and combat service support.

The battlefield of the future will be the "non-contiguous battlefield", popularly known as "islands".

Countermeasures such as "laser designator foolers" need to be available on the training battlefield.

| | |
|---|---|
| CPT Tinsley | OPFOR |
| Mr. Curtis | |
| Mr. Comber | |

Comments:

(Note: The following two notes represent completely conflicting opinions).

The only suitable place to simulate OPFOR weapons and tactics is at facilities such as NTC, CMTC, JPTS, Gowan Field, etc.

OPFOR can be created anywhere; units can train very quickly to use OPFOR tactics.

The use of OPFOR tactics in ARTEPS is FORSCOM doctrine. (Note: is it?).

OPFOR threats include Soviet, North Korean, others.

OPFOR weapons and tactics are simulated as they were ten years ago because of insufficient intelligence.

Angle of attack on an incoming tank round has a significant effect on $P_k$ and should be provided.

Soviet artillery tactics are being modified to provide even more intensive fire over a shorter period of time. Simulation should take this into account by completely disabling troops in a given target area for a measured period of time.

LTC. Heinze USAF Liaison

Comments:

There is a MILES pod for the A10 that enables it to take engagements from the ground.

The Air Force thinks the MILES for the A10 makes it too easy to kill.

The Maverick training system may be modified to take hits and kills.

About 12 A10s are used at a time at NTC. They are TDY from various areas, use George AFB as a staging area.

No other USAF aircraft are instrumented.

No USAF engagement simulation development is known.

Video trackers are used at USAF ranges to evaluate ground-to-air engagements.

The Air Force would be more interested in TES if there were a joint training area, one of very large size.

The Air Force would like all the weapons on the A10 instrumented.

The Air Force uses JMEN-type tables to assess casualties from bombs.

MAJ. Hickman LHX Development

Comments:

Imbedded training equipment on the LHX is being sold as reducing the life cycle cost by as much as 40%. This is mainly in the area of force structure and training.

Imbedded training in the LHX is primarily in software: navigation, fire control, etc. There is provision to have targets displayed by computer generated imagery.

Some imbedded training has been included in the Engineering Development Simulators for the LHX.

MAJ Kenney NTC Lessons Learned
CPT Burnett
CPT Demonbreun (NTC Lessons Learned Newsletter)

Comments:

A 1:4 ratio of SAWE rounds to real rounds simulated is a realistic compromise.

The A10s at NTC are not instrumented.

Don't get any AAR data from George AFB.

Poor participation by the Air Force, if any, in AARs.

There are bad reports from NTC on MILES AGES TOW: out of boresight, etc.

The MILES M1 system is easy to boresight.

The Cobra must be landed to boresight the MILES.

Target jinking can cause the MILES TOW to loose track with no provision to recover. This is not realistic.

It is important to add ID for the firing weapon.

Need superelevation, automatic lead, etc. for more realistic gunnery.

Need to involve the loader in the tank. This includes OPFOR as well as rotational units.

Need to simulate 50-cal. tracers.

On tanks, front kills with MILES are too easy.

TES/2:215

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TES/2:215

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-213-86
June 16, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the Field Artillery School and Board, Ft. Sill, Oklahoma May 15, 1986

| | |
|---|---|
| Mr. Larry Graham | CPT Terry Hemminger |
| Mr. Clay Turpin | CPT Stanley Oliveras |
| Mr. Jeddie Disco | CW3 Henry Croes |
| Mr. Michael Leatherman | CPT Robert Hahn |
| Mr. Jerry Goos | SFC Ronald Blackwell |
| Mr. Ronald Fox | SFC Robert Gregory |
| Mr. John Spicer | SSG Samuel Inmon |
| | CPT Bobby Paras |
| | CPT Roger Voss |

Comments:

There may be a general problem with using the 1780 intercom amplifer as part of the MILES tank intercom system.

MILES was used one time in 10 months in Korea, on a tank gunnery range.

In Germany, in 1980-1983, MILES was more of a problem on the major weapons than with small arms.

Artillery needs: cues for FOs, the ability to correct rounds.

Will it be all smart weapons in the year 2000? Nobody knows.

To simulate command and control problems, commo needs to be taken out on a selective basis.

Need to simulate the Electro Magnetic Pulse (EMP).

There are three areas in field artillery simulation: the battery, command and control, the target.

EW jamming is so effective that it is only done at the end of exercises.

A simulated round doesn't have to go anywhere; but it must be completely consumed.

The idea of a computer tie-in between a live fire range and a maneuver range has been tried by a National Guard unit.

TES/2:213

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-161-86
June 3, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with 1-77 Armor Battalion, 4th Infantry Division, Ft. Carson, Colorado, May 16, 1986

| | |
|---|---|
| CPT Willems | |
| 1LT Anderson | HHC |
| 2LT Berardini | A Company |
| 2LT Porter | A Company |

Comments:

MILES is susceptible to bugs.

The TASC at Ft. Carson does some qualification trainng on MILES, but there are not nearly enough people trained.

The TASC does not provide support in the field.

MILES cables need to be more clearly labeled.

Usually equip two companies at a time with MILES. It takes a half day to install MILES on one company.

Limited by MILES availablility.

Keys are re-manufactured.

MILES won't match even visual sighting in obscurants.

MILES on a tank main gun doesn't give enough hits, especially at short ranges like 500 meters. Maybe the spot size is smaller than the distance between detectors. (500 meter engagements are common at NTC).

MILES TOW is OK. The MILES may not have to be boresighted as often as the real weapon.

Did a 10-day war with MILES as part of Armor Officers Basic (AOB) training.

MILES has been used at the Painted Canyon maneuver area.

They train for NTC, which is not good because it is not realistic. MILES gives too many kills at long range (2800 meters) and not enough kills at short range.

There are too many heroes when fighting against MILES.

Having to reload Hoffmans is unrealistic.

There may not be enough zeroing of MILES on M16s.

There should be training for MILES itself: proper installation, proper boresighting, capabilities and limitations, some basic troubleshooting knowledge.

Tankers should have more realistic gunnery.

Artillery must be simulated.

TES must work in smoke.

At NTC, 15-minute delays in getting fire missions placed is common.

The experience at NTC with controllers maintaining realism is good.

Very impressed with the graphics at NTC. Company and battalion commanders must be able to see these graphics.

Controllers used at Ft. Carson aren't briefed nearly enough. Their first priority is being a safety officer.

Don't use fire markers, pyro, or smoke. Smoke pyro is a controlled item and must not be allowed to wander off.

Don't do enough combined arms training at Ft. Carson. NTC training is at a task force level. Therefore, when they get to NTC they don't know what to do with their engineers, air defense artillery, ground surveillance radar, casualties, etc.

Units don't prepare enough in the use of obstacles, which include mines.

They breech by using their engineers or by sacrificing a tank.

FASCAM is hardly ever used.

The AARs at NTC are becoming much more constructive; this really helps the teaching and learning.

AAR graphics in the field for units down to platoon level would be a good idea.

If simulation were realistic enough, it could do away with live fire. An advantage to this is that the number of constraints present in live fire, for safety, make it completely unrealistic.

Soldiers take kills very seriously and emotionally.

Commo kills are very important; there is too much dependence on radios.

At NTC, the TC, driver, and loader wear MILES torso harnesses. The gunner does not because he stays down inside.

At NTC, the controllers handle cheating very effectively.

How cheating is controlled at NTC: once, your commander is notified; twice, you're out of the battle. For OPFOR, it's once and you get an Article 15.

Training of controllers would only be effective if certain people were dedicated to that job.

TES/2:161

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-180-86
June 30, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with the 1st Brigade, 327th infantry, 101st Airborne Division (Air Assault), Ft. Campbell, Kentucky, May 20, 1986.

CPT Rodriguez
SSG Hugh Mills
SGT Todd Minicozzi
SGT Robert Bibby

Comments:

At Ft. Campbell, personnel from TASC and the CLS have gone into the field to investigate reported MILES problems.

The biggest problem with MILES is not the equipment itself, but the lack of training about the use of MILES.

There are problems with not enough batteries.

Rucksacs weigh 30-50 lbs; they could go as high as 60-65 lbs. in combat. In addition to the rucksac, there are the Load Carrying Equipment (LCE), canteens, ammo pouches, grenades, knife, and 100 rounds of machine gun ammo.

The LCE-type torso harness for MILES is a good idea, the electronics/battery box is just in the wrong place. Moving it around to the front would be worse.

The cross strap at the chest on the MILES torso harness must be redesigned. Too many soldiers are getting caught and choked by it.

The MILES electronics/battery box on torso harness might be moved to take the place of the first aid kit or the carrying of hand grenades.

Three different sizes of the Kevlar helmet are issued. The modified (new Velcro adjustment) MILES helmet harness still does not fit the Kevlar helmet properly.

The MILES laser transmitter on the M16 makes the rifle heavy and out of balance.

Soldiers have been charged $22 or more for lost MILES keys, $210 or more for a lost helmet harness.

Must get rid of the MILES keys.

Need a TES simulator for the M203 grenade launcher.

Need a TES hand grenade.

There are too many false kills with MILES; buzzers going off when no one is engaging.

When MILES was used in Hawaii, there were lots of cases of getting shot by your own flanks when they got bored.

There have been cases of EMI affecting MILES TOW.

Strongly recommended a MILES training film that could go to the field with MILES. 10-15 minutes would be the best length; 30 minutes would be too long. It could be shown to the troops in their day room.

There is a shortage of ATWESS. M80s have been substituted, but aren't as effective.

Don't get enough hits with MILES-TOW. The MILES sight is only 3-4 power vs. 12-power on the weapon. MILES works OK at 700-800 meters but not as well at 1500 meters and beyond.

There is no way to boresight the MILES-TOW. It can be zeroed.

Can't mount the TOW 2 night sight on the MILES day sight. Even the real TOW day sight bracket is a "pain in the neck".

TOW 2 is being used on jeeps. It is standard procedure to self-check the weapon every 4 hours; this usually sets off the MILES, probably a case of electrical interference.

Scout platoons are normally not instrumented.

The 25th ID in Hawaii is a big user and believer in MILES.

Foliage works as good protection from MILES.

There are too many MILES cables on a tank.

Have Dragon and Viper but don't instrument them.

Stinger is not now used by the light infantry; it is an air defense function.

MILES is still a fun game; the penalties are not severe enough. Night exercises really become a zoo.

The infantry soldier's MILES system has 3 batteries. He goes until the batteries are dead, and then keeps on going.

The screws on the MILES battery covers are beginning to wear out.

Company and brigade ARTEPS are 7-10 days. Squad level ARTEPS are 72 hours.

MILES TOW batteries get very hot.

Troops, as policy, take helmet harnesses off at night. Some soldiers "are so paranoid at losing stuff" that MILES loses it's effectiveness.

TES should use a common commerical type battery. Some MILES systems use odd types of batteries, a bad idea.

The MILES kit for M16s contains 20 systems; a scout platoon has only 10 people. The result is scouts aren't instrumented, since no one wants to be accountable for the extra 10 systems during an exercise.

There is a new Load Carrying Harness (LCE) about to be issued. It should be looked at for future TES application.

DRF requires troops to be ready to go directly from field training to the airport for combat. This would be a problem if they were using special training helmets, weapons, computer cards, etc.

Need TES for the Claymore mine. In combat, each soldier might carry 3 Claymores for both conventional and booby-trap use.

A red dot hit location indicator would be good for MOUT.

New TES system should incorporate a penalty for radio transmissions being too long (more than 8 seconds for example).

Infantry basic training includes use of MILES.

The Weaponeer system is used to train weak M16 gunners; it works very well.

75% of people in a heavy anti-armor company carry pistols.

New TES needs to be easier to learn and use than MILES.

Need an ATWES that is safe for dry vegetation.

Need to use advanced technology for logistical support of TES; decrease the effort to issue, use and turn in.

Individual's MILES equipment accountability hinders its use in effective training.

Zeroing of MILES takes too much time and effort.

MILES Vehicle Kill Indicator (VKI) light on vehicles is a satisfactory cue and signature.

Need to have mock threat vehicles for recognition.

CPT Rodriguez
1LT Michael Saulnier
1LT Carl Atkins
1LT James Markley
2LT Richard Kelley
2LT Stephen Twitty
SSG Hughes Patrick
SGT William Edwards

Comments:

The battery box on the MILES torso harness is painful when carrying a radio.

Battery boxes pop open.

There aren't any good instructions on how to wear the gear (Note: There are extensive MILES instruction manuals. They may not show how to wear MILES along with other combat equipment).

The upper shoulder area might be a place for a battery box if the MILES torso harness were more like the LCE.

Some soldiers wear both the MILES torso harness and the LCE.

There have been instances when MILES detectors have been activated by the sun.

Grazing fire, one meter above the ground, is a tactic taught for the M60 machine gun. It can't be simulated with MILES.

The helmet harness will not work satisfactorily with the Kevlar helmet.

The MILES M16 laser transmitter will go off if it is near an M60 machine gun when firing.

The MILES M16 laser transmitter will go off on its own when it gets wet.

The MILES system is good for soldiers fighting soldiers.

TASC has added lanyards to every MILES key.

It is important to play casualties. They now use the casualty cards.

A TES system must reward the guy who is doing things right, and penalize the guy who is doing things wrong.

Once you take the active controller out of the picture everything goes to pot.

Need more simulated incoming artillery than is provided by the hand thrown pyro.

The present pyro is dangerous and has a bigger bang than is needed.

For simulating incoming artillery, flash is more important than bang. Mines are simulated by pieces of wood that have to be recovered, but don't have to be accounted for. The latter is extremely important.

Would like to have two separate systems to simulate mines: inert blocks of wood to emplace; an RTCA device which covers the whole minefield.

Blocks of wood cut from a 6-8" tree, with a 20-penny nail in the middle, make great simulated mines.

Some thought needs to be given to how breaching is done.

Need a system to simulate attacks from A10-type aircraft.

Drones are tough targets to hit. Radio controlled drones with MILES would be realistic targets for engagements.

Uninstrumented Cobras are used now in exercises. This is very unrealistic.

Equipment loss should be played in addition to personnel loss. This includes TOW, machine guns, mortars, and, especially, radios.

60 mm mortars are being used.

Need something to make motorcycles targets.

The M203 practice round, if it hits you, is dangerous.

Present concept is 200 Claymores per company.

Being a controller is good duty, has great training benefit.

The MILES-equipped M16 is zeroed by adjusting the sight on the M16. This is very bad as the M16 is actually no longer zeroed for real rounds. The MILES should be zeroed by an adjustment on the MILES itself.

Marksmanship is important; the MILES targets need more detectors.

All casualty assessment should be automatic to eliminate controller kills.

Need pyro artillery cues that can be used in dry vegetation.

Need to keep TES expendables inexpensive so that they are used more often.

Need pistol simulation for TOC overrun effects.

Need simulation of demolition activities, such as bridge destruction, with penalty assessment for violation.

TES/4:180

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-181-86
June 30, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting with Artillery, Aviation, and Air Defense Elements of the 101st Airborne Division, Ft. Campbell, Kentucky, May 20, 1986.

Cpt. Rodriguez

2nd Battalion of 320th Field Artillery:

2LT Robert Salowski
2LT Gordon Bell
2LT Lynn Locklear
SGT Harry Cook
SGT James Hicks

229th Attack Helicopter Battalion:

1LT Wesley Trull
SSG James McCombs

2nd Battalion of 17th Air Cavalry:

CW2 Jerry Anderson
SP4 John Delandro

1st Battalion of 3rd Air Defense Artillery:

1LT Markael Padgett
2LT Keith Caldwell
SFC Eddie Lingunfelter
SSG Calvin Smith
SGT Graylen Carroll

Comments:

Nobody has seen enough real combat to evaluate what really happens in the artillery target area.

MILES problems with man-worn equipment in artillery crews (105s): its too heavy, the battery pack is in the wrong place, the helmet harness is bulky, it's too easy to lose keys.

Needed for artillery crews: simulated rounds for loading, counterbattery fire, a Copperhead simulator.

Artillery is a big target for A10s and these engagements need to be simulated.

Artillery does train to fire on moving targets.

An ARTEP is mostly planning, with some live fire, including 750 rounds of live fire for artillery.

There are only 4 MILES TSUs at Ft. Campbell. It takes a full day to mount and adjust a TSU.

MILES Cobra TOW has problems with dust at 2 km.

The MILES TSU drifts worse than the real unit.

Get too few kills with both the MILES TOW and 20mm cannon on the Cobra.

MILES doesn't simulate the 20mm cannon very well in that there is no simulation of wind effects, drop, etc.

The MILES Cobra system can push the gross weight of the helicopter.

There is no way to kill the Stinger weapon itself since it's not instrumented.

The rubber seal on the ATWESS is a problem.

The Stinger needs a dry fire mode to check weapon operation.

The MILES Vehicular Kill Indicator (VKI) light is too hard to see when flying a helicopter.

Turning a tank sideways is an effective way of letting pilots know the tank has been killed. Turning and elevating the main gun tube would work too.

Have used MILES for Stinger, Chapparal, and towed Vulcan.

Its too easy to kill the Cobra helicopter.

At NTC and in Korea, helicopters have been killed by MILES-equipped tank main guns.

One of the biggest weapon signatures is tracers. 4 out of 7 Vulcan rounds may be tracers.

Air Defense needs the Blackhawk and OA37s instrumented.

A10s are the big weapons, not F16s. A10 instructors are trained at Ft. Campbell.

Air-to-air combat is here now. Marines now have helicopters equipped with Sidewinder. This should be a high priority for future TES.

RTO (radio) targets must be made to stop transmitting as soon as they are hit.

Communications is not important to attack helicopters, but it is crucial to air cavalry.

Note that it is nearly impossible to jam two helicopters flying side-by-side.

A good system would provide a penalty if a radio is keyed too long.

Ft. Campbell has a MOUT training area.

There are real differences in fighting in urban terrain, even for artillery and helicopters.

Medics should be exercised, casualties treated.

MILES is used from squad up to company; bigger than this, it can't be managed.

These units rotate to NTC once every 18 months. It will take 4 years to get a whole battalion there.

An important piece of data for AARs is the number of rounds expended.

Most evaluation in ARTEPS is not unbiased because the evaluators can become the evaluated. A rotating evaluation team might be a cost effective improvement.

Need simulation of illumination rounds for night operation.

Need aircraft rocket weapon simulation.

Need cues for rounds landing from firing aircraft.

Need mobility kill effects.

Need simulation of artillery damage to buildings.

Need recorded video of everything.

TES/4:181

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-173-86
June 30, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at the Armor School, Ft. Knox, Kentucky, May 21, 1986

| | |
|---|---|
| SFC William Heemsoth | SFC Charlie Lindsey |
| SFC Larry Holden | SFC Monroe Wynn |
| SFC John Allen | SSG Robert Winnall |

Comments:

As part of Armor Officers Basic (AOB) training, the Armor School conducts a "10-day war". It's about three iterations a day (two in daylight, one at night) for 10 days with 20 vehicles in five 4-tank platoons.

Cavalry is trained separately using 20 vehicles made up of 12 Bradleys or M113s and 8 M60 or M1 tanks.

Usually use M60s because of high cost of using M1s.

Differences in M60 and M1 MILES cause people problems when swapping between the two vehicles.

BLUFOR vs BLUFOR is better for this type of training because OPFOR is too good for new officers.

Cannot use OPFOR at night because they have no thermal sights.

Real CS gas is used; drivers have to mask.

MILES availability for the OPFOR is getting worse, probably because attrition of equipment which is not being resupplied. OPFOR not being fully instrumented is very poor training.

Viper and Dragon are used in cavalry exercises; very seldom use TOW.

Very seldom use Bradley vehicles. Not only is cost high, but drivers and gunners can't be observed during exercises.

Have maintenance problems with MILES because it is old.

MILES test equipment is inadequate.

MILES troubleshooting is done by SP4s who do this as an additional assignment.

The 2nd of the 6th Cavalry supports the Armor School by checking MILES out of TASC and supplying to the Armor School instructors. This arrangement has lots of problems.

Crews are not instrumented because too much equipment was lost or damaged. Not considered a big loss in effectiveness because "who would engage them".

Tank MILES can't simulate High Explosive Personnel (HEP) rounds against dismounts.

MILES laser power drops off with time, a maintenance problem.

The MILES tank main gun laser must be boresighted often, but this is good training because the real gun must be boresighted often too.

Smoke hit cues are good because the smoke of burning tanks has effects, such as silhouetting, on the battlefield.

MILES keys are a major inventory problem; any new TES system should not have keys.

Additional TES data requirements are:

Engagement range
Target ID, weapon ID
Target location, weapon location (for mapping in the AAR)
Number of rounds fired
Type of rounds fired
Duration of radio transmission

Tabular data printout may be more useful than graphics.

Need imbedded training equipment; there are too many cables with MILES.

Not being able to engage through obscurants is a bigger problem than not simulating the other gunnery functions such as lead angle, superelevation, etc.

The lack of interest in gunnery simulation may only apply to the AOB exercises at Ft. Knox because they are training leadership, not gunnery.

New TES systems for tanks should involve the loader.

Mobility kills are important.

Commo kills are important, but there may be better ways than TES to simply simulate lost commo.

CPT Donald McAuliffe
CPT Paul Jussel

Comments:

MILES will shoot targets between trees but the real TOW might not.

Reloading the Hoffmans every nine rounds is unrealistic.

Communication between controllers can be a problem due to availability of radios, range, etc.

MILES is being used more for evaluation (ARTEPs) than for training.

People avoid using MILES because of the cleanup time.

MILES usage is increasing. It may be working down from the top or up from the bottom.

Having to count pulses of light on the MILES VKI to determine type of attrition is a bad idea.

MILES TOW 2 (on the ITV) may not have a long enough range.

Definitely need sensors on the rear of tanks. "Cavalry gets paid to maneuver for that type of shot."

More MILES sets would mean less mounting and dismounting.

Need experienced MILES maintenance teams.

Incoming artillery must be simulated with exposed personnel taken out rather than just killing tanks.

Mobility kills are an important need but not if it costs more money.

If a new generation TES doesn't replicate gunnery well, there won't be any shoot-on-the-move. That would be a problem in maneuver training.

A weapon signature needs sound as well as flash.

There will be more NTCs. Not everywhere, but at the training centers: Ft. Knox, Ft. Benning, Hohenfels, etc.

Rotating observers would be a good approach toward unbiased results but probably wouldn't work because no one wants to be on TDY a large part of the year.

Need the capability to resurrect with the controller gun to keep things moving.

Using imbedded TES laser detectors for tactical warning of laser designators and rangefinders would be a great idea.

The Hughes ANPVS-6 is an eye-safe laser rangefinder good out to 9 km.

SIMNET is a DARPA development that is a great simulator for the whole crew.

Need a better location or different design to reduce damage to the kill light on combat vehicles.

Need data base from TES exercises for Armor School.

Could use video display for replay in After Action Reviews.

Need to be able to attrit individuals in tank crews.

Need engagement capability between tank and attack helicopters.

Need capability for tank crews to be able to rotate positions.

Need interface between TES and trainer in Trainer Seat on each vehicle.

Trainer on vehicle should be able to demonstrate TES.

TES must create decision the stress of decision making.

Need to simulate antenna loss and field expedient replacement.

Battery accountability must be eliminated.

Need better designs for TES cables inside vehicles.

Need to reduce "MILES gamesmanship" in TES.

Need to have feedback of firing results to gunner.

Need to provide hit location information.

Need to have field BITE and repair by exchange of modules.

TES/2:173

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-174-86
June 30, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at the Army Aviation School, Ft. Rucker, Alabama, May 22, 1986

| | |
|---|---|
| CW4 Perry Smith | Directorate of Training and Doctrine (DOTD) |
| CPT Venjie Gose | DOTD |
| Mr. John Hogan | DOTD |
| CW2 Charles Butler | DOTD |
| CPT Larry Sisson | Dept. of Gunnery & Flight Subjects (DGFS) |
| Mr. Thomas Foster | Army Aviation Board |
| CW3 William King | TRADOC Systems Manager - Apache |
| MAJ C.T. Ebbinga | TRADOC Systems Manager - OH-58D |
| CW2 Tommy Collins | D Company, 229th Aviation Battalion, 101st Airborne Division |

Comments:

All OH-58s are now grounded for MILES AGES use. The kill indicator weight on the skids is causing structural cracks.

Main problems with belts is the attachment; taking screws in and out.

Belts have also come off. Belts are very strong initially, but they wear.

Should consider using optical links to connect the detectors rather than belts.

The cockpit indicator is a problem because of where it is mounted.

Helicopter systems upgrades, product improvements, have great impact on belt configuration and belt installation.

MILES TOW tests the system better than the combat TSGMS.

First issue of MILES TSUs was seven for each installation. Of these seven, four working would be good; some installations only got two or three.

Policy is that TSUs are modified to add MILES only when they go bad. This work is being done by Anniston Army Depot at a claimed rate of about 20-30 a month.

There is a reliability problem with all TSUs, but it impacts the MILES TSUs the most. Some MILES TSUs arrive with no window, wires not hooked up, etc.

The MILES hit indicator in the vehicle is not adequate. Need immediate feedback: a cockpit indicator, etc.

Don't use the smoke kill indicator on the Cobras enough; short of smoke cartridges. Smoke canisters cost $18-40 each.

Need separate kill codes for like weapons; ground TOW and aircraft TOW, for example.

TES for helicopters should be smaller. The weight of TES is not always offset by not carrying ammo. Sometimes both are carried, such as when going to live fire.

AGES has no Identification Friend or Foe (IFF). IFF is too important not to be part of future weaponry. It is here to stay and must be incorporated in future TES systems.

Ft. Riley has reported problems with boresighting the MILES AGES.

There are compatibility problems. Some MILES boxes work on some aircraft but not on others. The reasons for this must be considered in future systems.

A training device must not task the TO&E unit more than they already are or it won't be used. Training systems must make the TO&E job easier and more efficient.

There were reliability problems with MILES used on Apache during tests at Hunter-Liggett. Also, problem of no hits registered when there should have been.

There is absolutely no feedback to the gunner after a miss.

The gunner looks through sights when firing the 20 mm and 30 mm cannons. There are tracers with the 20 mm, none with the 30 mm.

Heads Up Display (HUD) is used when firing the 2.75" rockets. Rockets are normally used in the direct fire mode, sometimes indirect fire.

The Cobra is not a nightfighter, therefore MILES AGES is not used at night.

Apache is a nightfighter and TES for Apache must be usable at night. This means TES equipment must be compatible with the use of night vision goggles: cockpit indicator, etc.

Data requirements: who shot whom, time of trigger pull, altitude, position, weapon system used, time of target attrition, rounds fired, engagement description (adjustment of fire, etc.). Best method would be onboard recording with provisions to dump into a base station computer.

$P_k$ should be more sophisticated, i.e., take into consideration prior hits, for example.

Hellfire, with the remote designator, needs to be simulated.

A tank sabot round has a high probability of killing a helicopter at 5000 meters and must be simulated.

Stinger countermeasures are not simulated in MILES AGES, and should be.

Future TES must address Aircraft Survivability Equipment (ASE); i.e., countermeasures which affect $P_h$ and $P_k$.

Simulating OPFOR, equipment and tactics, is essential. Threat simulation must include VISMOD, OPFOR weapon performance, target vulnerability characteristics.

In training, one pilot wears MOPP gear and flies; the other is not suited up, acts as safety. Air crews use the M24 mask.

Altitude is an enemy for helicopters; they can be treated as tanks in the NBC combat environment.

Need onboard reset to continue the action, but reloading the smoke canister would be a problem.

Imbedded training equipment is the way to go. Some possible advantages: reduce overall weight, use engagement laser for rangefinding or for data transmission between aircraft, use detectors as warning of being lased, provide improved tactical equipment checkout, facilitate zeroing and boresighting of actual weapons.

Need variable hold-on time when simulating TOW.

Would be willing to trade quantity for quality.

New weapons will include air-to-air Stinger, Hellfire, laser or other directed energy weapons, multiple warheads.

Need simulation of chemical weapons.

Need to have TES friendly to people for use and testing and maintaining. Should have BITE.

Need to have aircraft combat ready at all times, including when TES is installed.

Need to decrease number of Army people involved in extra training functions. Could have OPFOR and others be civilian contractor personnel. Example is Rucker flight instructors.

TES/2:174

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-182-86
June 30, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at the JFK Special Warfare Center, Ft. Bragg, North Carolina, May 29, 1986

| | |
|---|---|
| CPT Mark Williams | MAJ Dan McKinney |
| CPT Daniel Beliveau | MAJ Alex Wojcicki |
| CPT Lonnie Lee | Mr. Bob Haskell |
| SFC Phillip Childrey | Mr. Bob Mountel |

Comments:

MILES for the soldier is too cumbersome, especially the helmet and torso harnesses.

They have 200 MILES M16 sets, 16 controller guns, 16 machine gun sets, 16 Viper sets, and 4 alignment fixtures. This is inadequate.

Would use MILES at squad level or below, even with just two soldiers.

MILES should take into consideration the limitations of weapons such as range. For example, the MP5 is not good except at close range.

Need more transparency.

One third of the weapons used by Special Forces are foreign or non-standard US weapons. Differences are magazine capacities, rates of fire, weight, etc.

Special Forces use handguns, mostly foreign.

Use Claymore, and its foreign equivalents, and demolition charges.

Special Forces do MOUT training.

Except in counter-terrorist missions, if the Special Forces get into a shootout something has gone wrong. Their main objective is gathering intelligence 100-150km behind the lines.

Special Forces provide terminal guidance for interdiction strikes.

It's important to teach individual battle drills and maintaining cover. Initially in Vietnam, many losses were due to soldiers never having been shot at.

TES should have the capability to put on an ambush. Some engagements are as close as one or two meters.

For AARs, data needed is: what weapons were fired, when, how many rounds, when the engagement was over. Data must be presented in a quickly usable form; nobody has enough staff to spend much time reducing data.

Need to know where a spent round went when there was no engagement.

Intervisibility data would be of interest.

MILES M16 doesn't simulate bullet ballistic, i.e., lead for running targets, wind effects.

MILES M16 won't penetrate soft camouflage.

Special Forces use night vision devices to maneuver at night.

Communication is a big part of recon. If you stay on the air for 20 seconds, you're dead. This should be simulated.

Jamming and monitoring are used and trained.

Electronic Warfare is played both ways. Present methods are effective; see no real need for new equipment.

Controllers don't get enough training.

Controllers spend too much time on administration.

In an ARTEP for 700 troops, nearly 250 Special Forces umpires (a battalion) were needed.

For Chemical Warfare, need to access casualties against soldiers who are not doing the right thing.

Nuclear Warfare is of lower importance to Special Forces. Rangers, however, may be likely targets for a nuclear strike. Letting troops know what a nuke strike is like may be important.

Mustard gas is a key concern for Special Forces.

Decon may be more of a problem for the command and control than for the troops in the field.

Need to simulate enemy detection of ground units by thermal means.

For Air Defense, Special Forces will attack enemy aircraft both in the air and on the ground with a variety of weapons: Stinger, sniper rifles, enemy weapons such as the ZSU.

Future TES needs to be more soldier-proof: reduce maintenance, cleaning, issue, etc.

Reserve units have Maneuver Area Commands which are dedicated to training.

Controllers or evaluators could be civilians, not 19-year olds, but retired military, etc. They're used now.

Being a controller loses its training value, for the military, after the third or fourth exercise.

If controllers, civilian or military, came from the schools, there would be great feedback for doctrine.

Without realistic gunnery simulation, its hard to maintain interest of soldiers in any kind of extended exercises.

Crew drill gets boring real fast, but there is a crucial need to train crew skills. The goal is to have soldiers perform correctly as second nature.

Attrition penalties might vary with the level of training, i.e., take it easier on the new student than on the experienced soldier.

Special Forces may have a requirement for TES equipment to be completely waterproof.

Playing casualties is not a critical need.

When the OPFOR fights Special Forces, it uses Special Forces tactics.

Joint Special Operations Command (JSOC) at Ft. Bragg is responsible for counter-terrorism.

Need to simulate the 81 mm mortar.

Need weapon blanks and blank adapter for foreign weapons.

Need drones or foreign aircraft VISMODS.

Need TES shoot-back targets in live fire training.

Need to be able to operate in obscurants.

Need TES training for world-wide missions.

Need TES for training squad and two-man missions.

Need TES to simulate air operations interfaces.

TES/4:182

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-177-86
July 1, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at Ft. Bragg, North Carolina, May 29, 1986 with units of the 82nd Airborne Division, North Carolina National Guard, Ft. Bragg TASC

82nd Airborne Division:

| | |
|---|---|
| SGT Travis Wear | 1-505th Infantry |
| 1LT Mark Subsinsky | 3rd Brigade Training Officer |
| SFC Robert Heeks | 3rd Brigade HDQ |
| SGT Jeffrey Sutpnin | 307th Engineer Battalion |
| SP4 Randall Crum | 307th Engineer Battalion |
| MSG John Page | Division G3 |
| 1LT Robert Avcoin | Division G3 |
| SGT Leonard Jackson | Division G3 |
| SFC Richard Stone | Division Artillery S3 |
| CPT Arthur Kohn | HHB Division Artillery |
| 1LT Andrew Parker | 3/4 Air Defense Artillery |
| COL Howard Paris | XVIII Corps G3 |
| SGT Carlo Lazard | 1/17 Cavalry S3 |
| Larry Brooks | 1st SOCOM |

North Carolina National Guard:

| | |
|---|---|
| SFC Foy Jones | HQS |
| SSG James White | HQS 2-252 Armor |
| SSG Daniel Johnson | HQ 2-120th Infantry |

Other:

| | |
|---|---|
| Mr. Douglas Carr | TASC |
| Mr. Howard Surette | TASC |
| Mr. Romy Hernandez | TASC |
| Mr. D. Weitman | TASC |
| Mr. Joseph Wray | Loral-EOS |

Comments:

There is no difference in the MILES kill probability between the M60 tank and the M1; a MILES LAW can take out an M1.

A MILES TOW should not knock out an M1 with a frontal shot.

Ft. Bragg has only 21 MILES M1 sets.

MILES MI6 rifles and M60 machine guns used at Ft. Hunter-Liggett were very realistic.

The metal rings around the detectors on the MILES torso harnesses cut the internal wiring while the soldier is walking around.

Airborne troops use the "parachute retention straps" to hold down the MILES helmet harness.

The MILES torso harness is worn on top of the rucksac. Heat buildup was a problem at NTC when the torso harness was worn under the rucksac.

A better place for the MILES electronic/battery box would be on the pistol belt. Tankers don't wear the pistol belt though.

A very beneficial controller's school was held at Ft. Stewart for the National Guard with about 30 students. No Regular Army personnel were in attendance.

Cheating can be cut back by making TES more of a constructive experience, less of a game to be won.

Many MILES sets returned to TASC show groups of equipment modified, not just one or two. This indicates a squad-level decision to cheat.

It is bad practice to zero the MILES M16 by adjusting the sights on the rifle, then having to re-zero the rifle after removing MILES.

A National Guard gunner did not feel that "turning down" the computer in the M1 to use MILES is a problem. The MILES laser does the same thing as the computer in real gunnery when the computer is on.

It is important to do gunnery in the degraded mode, which means no computer.

Ft. Bragg has an Army-unique Sheridan tank battalion which will be going to NTC.

It's much easier to boresight the main gun on the M1 than on the M60, so it's done more often.

Cold weather affects the MILES SAF, but not the MILES itself, including no problems with batteries.

It would be beneficial to be able to track individual infantrymen.

The clip on the battery cover of the MILES M16 rifle laser is a better arrangment than the screw fasteners on the other two man-worn units.

The Kevlar helmet is supposed to stop a 7.62 mm round, so why have detectors on the helmet?

Casualty cards should be handed out by controllers, not issued beforehand to the soldiers.

An automatic way of assessing casualties, using TES, would be very desirable.

Artillery simulation at the battery: need to do everything the battery crew normally does.

On the 105 mm, the empty canister comes back out, so maybe having to unload a (46-lb) dummy round isn't such a bad idea.

Any artillery simulator should not leave trash on the battlefield.

Need round-for-round simulation of mortars. The 81 mm, 60 mm, and for awhile, the 4.2 inch, are being used now.

For counter-battery fire, both the weapon and the crew should be instrumented, with the weapon being the more important.

Resupply must be played realistically. One crew at NTC got a unit commendation for resupplying themselves from dead tanks.

If the loader isn't involved in engagements, then he's up observing, which is not realistic.

Recoil in a tank is not important.

Tank crews wear CVC helmets which reduce tank gun noise to about the level of the Hoffmans.

Recoil may be more noticed with artillery, but may still not be essential.

Artillery crews interest would be very high if they were getting feedback from the target area, via the FO, on targets hit, miss distance, etc.

Artillery target accuracy is judged on the basis of a 150-meter circle which includes, but is not centered on, the actual target coordinates.

Each artillery battery carries its own counter-battery radar which should be involved through simulation. This is the Q36 radar. P37 radar is used with heavy artillery.

Special Forces needs: SAW, LAW, M16A2, mines (Claymore in particular), ambush weapons (mines, booby traps), AT and AP mines.

.45 or 9mm pistol simulators could be used right now.

It would be very useful to have a hand grenade simulator.

Special Forces deal with individual mines, so a correct size/weight simulator would be required.

Lots of training equipment (mines especially) isn't being used because of accountability.

BLUFOR vs BLUFOR exercises aren't a problem; all simulators should be US types.

In Air Defense, BLUFOR vs BLUFOR is okay for fixed-wing aircraft, but not for helicopters. UH-1s don't simulate Hind-Ds.

Modifying the $P_k$s for different platforms is more important than VISMODs.

The MILES for the M1 tank doesn't get enough kills for sabot rounds at 3 km.

Drones as targets don't have a future. Army helicopters are usually available for helicopter targets; drones aren't good enough to simulate fixed-wing aircraft.

Need to simulate IFF.

The OPFOR is not given missiles when the BLUFOR is flying in. Another example of "we're not playing what would hurt us".

Special Forces uses sensors which should be simulated: acoustic, motion and heat detectors, etc.

TES in a vest would be better than web gear.

Need counter-battery simulation for artillery.

Need a TES cheat cue for cheaters and controllers.

Need simulation of fire with "kick out rounds".

They found MILES worked well in Alaska.

Need VISMOD for simulation of OPFOR tanks.

Need "where hit" for medical simulation.

Need TES for pistols.

Need to be able to attrit C130 fixed wing.

Need TES to provide simulation of battalion basic load.

Need artillery tube error information.

TES/3:177

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-178-86
July 1, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at U.S. Army Infantry School, Ft. Benning, Georgia, May 30, 1986.

| | |
|---|---|
| MAJ Robert Candido | Mr. Chuck McIntosh |
| Mr. Gary Hubbard | Mr. William Thomas |
| Mr. Dick Caravana | Mr. Haroldean Peace |

Comments:

The problems with MILES simulation of the M16 are: no lead, instantaneous pairing, no trajectory, no wind effects.

An imbedded TES laser in the M16 rifle would be a good idea. Should investigate combat use as rangefinder, boresight device, target designator.

Would like to use TES to teach gunnery. This would supplement, but not replace, live fire gunnery.

Rifle qualification is firing 40 rounds in a few minutes, so this is not a good candidate for simulation.

Simulating malfunctions is important; having to fire blanks usually takes care of this.

Need to improve the replication of live round dispersion by the TES laser spot.

The next Army rifle, the Advanced Combat Rifle (ACR), may have caseless cartridges, optical sights, fire three projectiles per shot.

The M203 grenade launcher can be used in the direct fire mode up to 100 meters, but is usually fired in the indirect fire mode, at targets that can be seen. It should be simulated.

A simulator for the hand grenade is of about the same importance as the simulator for the pistol.

Using soft camouflage to hide from MILES is negative training.

$P_k$ should be raised when there are prior hits.

There is no interest in adding a wounding type of attrition so that the treatment of casualties can be added to exercises.

All players on the battlefield should be instrumented; HMMWVs, 2 1/2-T trucks, etc.

The cannon on the Bradley doesn't shoot blanks; this is a problem in actuating MILES.

In simulating incoming artillery, bang is the most critical, smoke is the least. Actually only need a unique cue of some type to indicate that it's artillery, not something else.

Surrogate weapons cannot be used because they are too unrealistic. Providing a bang using gases stored in bottles wasn't acceptable because the gas leaked inside vehicles.

For the .50-caliber machine gun, only sound is needed to identify the type of weapon. Flash is not important since it's almost never seen in combat. (Note: what about tracers?)

The .50-caliber machine gun is not hard to clean after firing blanks, contrary to what had been reported elsewhere.

The new TOW will be fired from defilade.

FOG-M will be replacing TOW by the year 2000.

By 2000, there will be fly-over, shoot-down antitank missiles.

TOW 2 has a thermal beacon; the IR sight is the primary sight.

"Redout" is the flash immediately after firing TOW; it must be simulated.

AAWS-M is the replacement for Dragon; it will be fielded by 1995-2000.

Any new TES system must be compatible with the existing training system, i.e., MILES.

Tracers are important for machine guns, but not for small arms.

Need TES for training battalion-size logistics.

TES must simulate thermal, sights.

Need simulation of ground-to-air weapons against fast movers, drones, helicopters.

Need TES to provide data for Infantry School combat developments.

Need better capability against such as cheating, cheating code or cue.

TES/3:178

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-179-86
July 1, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Visit to the TASC at Ft. Benning, Georgia, May 30, 1986

Miss Crosby

Comments:

Each piece of MILES equipment is given an operational check after being returned from the field and before being put in storage. For example, each detector on a MILES torso harness or helmet harness is tested with the controller gun for proper actuation.

TASC issues only one battery for each application, rounding up to the box size of 24 which provides a few spares.

Double batteries are issued for 30-day exercises.

In emergencies, used batteries are issued. In this case, double quantities are issued.

A WD40-type water drying spray is applied around detectors, to battery box covers, etc., to retard corrosion, which has been a problem.

Have had MILES since 1980. Some of it looks quite worn.

New MILES arrives from time to time.

There are more than 2200 MILES M16 sets at Ft. Benning, approximately 1700 at Ft. Bragg.

Usual turn-around time to the Loral CLS is one day.

Most repair problems are due to wear and tear rather than design or hardware malfunctions.

This TASC has 15 or so of the Dragon Launch Simulators (not a MILES item) which aren't popular and aren't asked for often. They can be dangerous. They are very loud; a problem for instructors.

The MILES storage boxes are well liked. Some weigh more than 190 pounds but are handled by two men. The retaining wires on the lids break, followed by breaking of the hinges.

TES/3:179

JET PROPULSION LABORATORY

INTEROFFICE MEMO
375-235-86
August 10, 1986

TO: Distribution

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Tactical Engagement Simulation Meeting at U.S. Army Combined Arms Training Activity, Ft. Leavenworth, KS, August 5, 1986

The purpose of this return visit to Ft. Leavenworth (see IOM #375-215-86 for a report of our first visit on May 14, 1986) was to obtain additional information on future Army weapons, concepts, and doctrine, to support the future generation Tactical Engagement Simulation (TES) prioritized needs.

FORCE 95

A description of Army Air Land Battle (ALB), Force-1995 (known as Force 95) was given by Robert Keller of the Combined Arms Center Development Activity (CACDA) Force Design Directorate (FDD). A copy of his presentation is attached to these minutes.

Comments on Force 95 which pertain to TES:

Force 95 would be a force restructuring of the Army echelons, above battalion, for the 1995-2005 time frame.

New material (weapons) considered for Force 95 include Joint-Service, Vertical-Lift, Experimental (JVX) aircraft, Light Helicopter, Experimental (LHX), Tactical Army Combat Missile System (TACMS), Unattended Aerial Vehicles (UAV), and Armored Family of Vehicles (AFV)

Fiber Optic-Guided Missile (FOG-M) technology will be fielded earlier than 1995.

These new weapons drive the force design study, rather than needs driving the technology.

New concepts and proposals that may impact future TES are: deception (electronic and physical), US3 (Support Structure Study), E-Force (use of Engineers), K+ Force (reorganization of CCS in armor), Forward Area Air Defense Systems (FAADS) (replacement for Sgt. York), and the use of outer space.

CAC will be the proponent for some new weapon systems when proponency cannot, for one reason or another, be assigned to one of the schools.

Air-to-air combat (helicopters) is part of what is called Counter Air (CA). CA includes Air Defense Artillery (ADA), air-to-air, and all other shooting at aircraft such as by infantry and armor. Proponency for CA has not yet been assigned.

Force 95 is not currently considering any Directed Energy (DE) weapons. All DE technology is classified, Secret or above. FDD at CAC deals only with unclassified technology.

There is a trend toward more multiple use of new weapons systems. An example is the use of FOG-M for for both anti-armor and anti-air.

It is not clear at this time how future TES will be used by Army Reserve components. The Force 95 study will not address this aspect of future use of the Reserves.

## FUTURE WEAPONS

A description of probable weaponry to be found on the battlefield in 1995-2000 was given by Ben Stutler of the Requirements and Documentation Division, CACDA Material Integration Directorate. (No Handout)

Comments:

Armored Family of Vehicles (AFV) will be in the 1995-2000 time frame. This apparently means Initial Operational Capability (IOC).

A 900-meter sniper rifle is in the offing.

FOG-M will be in use by 1995. It will be used in conjunction with Elevated Telescopic Acquisition and Designation System (ETADS).

Another weapon will be the Long Range Antitank System (LRAD).

Advanced Antitank Weapon System (AAWS) will include Light (like the AT-4), Medium (like the Dragon follow-on), and Heavy (perhaps a hypervelocity missile).

Volcano is a system to "negate" minefields.

Multi-spectral (IR-defeating) smoke will be in use.

A whole new family of NBC detectors will be in the field by 1995.

The Infantry School is looking at a fragmenting small arms round in caliber 7.62 mm or larger. It has a time fuse. Burst can give the effect of shooting around corners.

Directed energy weapons, including one for use by dismounted infantry may be in the works.

## ARMY 21

Mr. Bob Carlson of CACDA Concepts Development gave a description of Army 21, the Army doctrine of the future which will follow Air Land Battle. Copies of part of his presentation are attached.

Army 21 is in the Interim Operational Concept stage.

The latest decription of Army 21 is a classified document, Secret.

Army 21 is the doctrine for the first quarter of the 21st century.

It is a Concept Based Requirement System (CBRS) mode, i.e. the need drives the requirements; the requirements identify technology areas requiring R&D.

It gets the Army out of the Active Defense oriented mode to go on the offense, focusing on defeat of the enemy instead of holding or acquiring terrain.

It will add depth to the battlefield.

Army 21 is much like guerilla warefare, on a larger scale. Or more like the Marines have been operating.

Because Army 21 is in the 2010 to 2025 time frame, it is generally beyond the scope of the JPL future TES work which is looking at 1995-2000. However, it is quite likely that as Army 21 develops there will be a number of earlier spinoffs which will become part of Army doctrine for 1995-2000. These would certainly become drivers then for TES needs in the JPL study.

It is expected that Command and Control, and Combat Service Support are two areas where Army 21 doctrine has a high probability of coming into play early.

TES/5:235

**JET PROPULSION LABORATORY** **INTEROFFICE MEMORANDUM**

Ref:OS-355-86-
File:OS/D:FAIRCHIL
TO: Distribution 10 September 1986

**FROM:** W. L. Dowler/J.Z. Inskeep Sec. 355/375 Ext. 3169

**SUBJECT:** Tactical Engagement Simulation Meeting at Fairchild Weston Systems, Inc. Syosset, New York, August 28, 1986.

Attendees:

Training & Simulation Systems, Fairchild Weston Systems Inc (part of the French Schlumberger).
Robert J. Coleman, Jr., Product Marketing Manager (Point of Contact)
Howard M. Gabbert, Director of Market Development
Robert Vance, Marketing Manager
Abraham Green, Engineering Manager
Norman M. Gutlove, Manager Program Development
Patrick J. McNelis, Manager Program Development

JPL: Warren L. Dowler
Jon Z. Inskeep

The following is a summary of the major points of discussion regarding current and future technology that could be used for TES (Future MILES).

Comments:

Personnel were very friendly and helpful; answered all of our questions in a forward manner; there was little evidence of any marketing hype or selling to JPL from the marketing personnel. We presented a short status discussion of current JPL SAWE efforts.

We brought home a vioeo tape giving a summary of Weston Simfire and the Fairchild marketing pitch on TWGSS.

The Training & Simulation Systems group is new at Fairchild--about 4 people last year and currently building to over 30; Fairchild realized that training and simulation was a new market. They feel that many of their products and technology fit well into simulation devices, and intend to be an aggressive competitor in this type of work.

Fairchild is or will be working on the following: a) Army contract to produce the helicopter AGES II. b) Bid on producing the additional buy of MILES. The Army is in the process of buying $116 million worth of additional MILES, 25000. units on a build-to-print basis. c) Bid on the TWGSS with their British partners (Weston Simfire) when it is released. They are part of an international integrated commercial organization.

The technology that they will have in AGES II will answer almost all of the needs and MILES problems that were expressed to us by Army air combat personnel. We were surprised by this. It seems that there is or was some direct route for the Army needs to be expressed as requirements to the contractor in AGES II, but we did not have anyone at Rucker or Germany mention that their needs were being met in AGES II. These needs may have been

identified by Chuck Tallman of ATSC in a follow-up evaluation of basic MILES about a year ago.

AGES II will not be "embedded", but AGES II "boxes" will fit into and replace real boxes. Time to install MILES AGES II in the aircraft is fixed in the contract and is about 1.5 hours per aircraft by the one MOS individual who maintains these items. (They recognize that the Army, like the Air Force, does not have the air crews do any maintenance, and aircraft maintenance personnel are highly trained; this is unlike the rest of the Army--the tank crew installs MILES.) The Cobra TSU, a real problem for MILES, will be replaced by a LRU in Apache. The LRU can be changed out in jut 15 minutes. Their new detector belts will have fewer sensors, be easier to install and maintain. They acknowledged that fiber optics or power for signal amplification at the sensor/detector would provide even more capability in the future for TES.

The AGES II system will use current state of the art technology which is very advanced when compared with earlier MILES technology.

They plan on AGES II to have the following new capability:

a) Player ID code.

b) Interface with the helicopter 1553 bus--which they can take data from but cannot introduce data into (this limitation may be a problem in the future for TES). Use of this bus will permit future TES to implement ballistic correction.

c) Event data storage/retrieval (but they don't know how the Army will use the data).

d) Fault isolating Built-In-Test.

e) Non-pyrotechnic smoke generators for hit cues; they will use theatrical smoke generator technology similar to FOG oil smoke. This is the type of smoke used extensively in the Broadway show "Cats." A small smoke generator unit is made by Roscoe in Germany. It would appear that they would use electric power to vaporize something like polyethylene glycol (PEG 200) for a helicopter hit cue. (This approach and technology is of major importance to other TES simulations: it would eliminate pyro safety problems, is low cost, and could provide much more smoke for longer durations than normal pyrotechnics. Perhaps it could also provide local obscurant simulation effects for the weapons platform. If colored smokes could be produced an embedded signal device could be made.)

f) A voice synthesizer for pilot information transfer and cues from MILES.

g) The effect of the use of Aircraft Survivability Equipment (ASE) in the MILES AGES II aircraft vulnerability algorithm; this includes use of chaf and flares as well as radar, IR, etc.

h) A radio link with a ground unit to simulate Hellfire indirect fire.

i) Eye-safe laser rangefinder. They expect laser and detector technology to advance rapidly during the next few years.

j) Several 80C88/8031 microprocessors.

k) Waypoint navigation and spot tracking.

l) Expandability for introduction of new weapons. The first might be simulation of the Hydra 70 rocket system as an area weapon in the direct fire mode.

The AGES II will interface with the following aircraft: Apache (AH-64A), AHIP (OH-58D), Blackhawk (UH-60A), Chinook (CH-47D). Initial delivery will be six systems for each type of helicopter in May 1987 for testing at Ft Hood.

There will be a MILES Hellfire ground support system that is compatible with FIST-V.

AGES II will have a new controller device (God gun) with all the old functions plus: loading of additional MILES rounds, output device for AGES II data to hardcopy, time line synchronization for all AGES II players, assigning player ID, reset or resurrection of the player, initiation of the AGES II system.

AGES II does not now have air-to-air combat or directed energy weapons considerations.

MILES is now used as a generic term; it does not refer only to the Loral-produced equipment.

Fairchild expects that future TES technology will include more sophisticated simulation of gunnery. Embedded training systems will only happen if they are dual purpose, i.e., have some use in combat.

Fairchild is a source of small, high-technology CCD video systems.

MLD:wo

Enclosures:

Distribution

S. Aspland File
D. Griffin Info
G. Miller Info

JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM
375-286-86
October 31, 1986

TO: Jack Battenburg

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Trip Report, Visit to Simfire Division of Solartron Defence Systems, Middlesex, England, October 3, 1986

Dr. Mark A. Skipper, Engineering Manager

Comments

Current TES systems are:

| | |
|---|---|
| Simfire S | Solartron's latest generation tactical and gunnery simulation system for tanks and armored vehicles; uses modular components. |
| Simfire M | A tactical simulator for anti-tank and anti-aircraft weapons, such as TOW and LAW. Can simulate missiles as simple as the Russian RPG-7. |
| Simfics | A tactical simulator for the Chieftain and Challenger tanks, which have the Marconi IFCS gun control system |
| Simlan | A tactical simulator for the MILAN anti-tank weapon |
| Simfire K | Target systems for vehicles without weapons, such as combat support vehicles |
| Simgun | A tactical simulator for small arms (not made by Centronics, not Solartron) which is not compatible with other Simfire |

Simfire systems have been in use for about 15 years. The earlier systems were more simple than those in use today. Orginally, Simfire had radio transmitters on the targets instead of retro-reflectors. Modern Simfire systems, in use for about 5 years, have modular components and have replaced radios with retro-reflectors. The latter was technology pioneered by Saab. The use of radios was discontinued because of frequency allocation problems. Note that this same problem must be solved if SAWE is to use RF transmission in any type of operation.

The Simfire S modular systems separate some target and weapon functions by having target modules, weapon modules, and common modules. A combat support vehicle without weapons would thus need only the target modules and common modules. This should result in lower cost and some system simplification.

Simfire, like all precision gunnery simulators, is a duplex system. That is, it requires a cooperative target for the return of information to the weapon (as is done by the retro-reflector). In a simplex system, such as MILES, no information is returned to the weapon except perhaps for the hit cues. Duplex

systems are required in gunnery in order to obtain actual accurate target parameters, such as range and size.

Simfire uses a scanning laser with extremely small spot size, providing a system error of ±.3 milliradians. Scanning, in combination with the retro-reflectors, allows the attack system to determine where the target is in the overall sight picture and thus be able to display fall of shot and burst on target.

Use of laser detectors at each retro-reflector, allows determination of hit sector, and in a crude way, angle of impact. This information can again be used as precision gunnery data.

Simfire scanning lasers are scanned mechanically now; expect to be scanned electronically in the future. The wavelength will probably be changed to get more range and still be eye safe.

There are three types of gunnery, listed below in order of decreasing precision:

1) Tank main gun - target is directly under the reticle.

2) Bradley chain gun - The next target appears on the edge of the sight picture.

3) Helicopter gunnery - iron sight with 30° x 50° field of new.

It will be a challenge for gunnery simulation systems, which scan the target area, to accommodate the wide fields of view in the lower precision gunnery systems.

The biggest problem with interoperability of simulation systems is to get the performance of different systems to match, i.e. MILES is a "big beam" system and kills are too easy (per Dr. Skipper) compared with the move sophisticated, more precise beam width Simfire kills.

DFWES (Direct Fire Weapon Engagement Systems?) is a big program in the UK that is trying to define an industry standard to promote interoperability.

Solartron has delivered 500 Simfics kits for the Chieftan tank and 600 kits for the Challenger tank. There is one Simfics for every tank in the British army inventory. A SIMFICS on the Challenger costs about $30,000.

There is little simulation instrumentation in the British army for other than tanks.

The British army training areas are at Salisbury Plain, England; Batus, Canada; and in Germany.

A British government agency, RSRE, is doing work on intervisibility; they should be willing to talk to us.

There is little being done with aircraft except for Lynx-TOW and making some helicopters into targets.

The British system for dismounted troops is not made by Solartron and is not compatible (will not operate with) Simfire. The British army does not play force-on-force with mixed weapons; it's tank on tank or platoon of dismounts vs. platoon of dismounts.

cc:

R. Beaudet
J. Bruman
N. Ferraro
D. Griffin
G. Henry
D. Maynard
G. Wiker

JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

Ref:AODC-355-92
File:AT/B:MARCONI
31 October 1986

TO: J. Battenburg

FROM: Jon Inskeep/Warren Dowler Sec. 375/355 Ext. 3169

SUBJECT: Trip Report, Visit to Marconi Command & Control Systems, Surrey, England, October 6, 1986

Persons contacted:
Marconi Command & Control Systems, Gunnery:
Mr. Michael Park, Group Project Manager
Mr. Rex A. Pope, Project Manager
Mr. W. Brian Davies, Technical Manager (MARTAC)
Mr. Alan G. Brandon, Manager Ordnance Systems Division

Mr. Jerry Pogorzelski, Project Engineer, Educational Computer Corporation (ECC), Orlando, Florida. ECC is the American associate for Marconi.

Marconi Command & Control Systems, Mines:
Mr. David G. Robins, Manager Weapons Systems Group

Summary of Laser Gunnery Simulation:

Marconi produces the MARTAC Tactical Training System which is very similar to the Solartron Simfire system; this is probably because Marconi and Solartron had some common technical personnel several years ago (some people stayed with Solartron and some went with Marconi). The distinguishing differences between the two systems are: MARTAC's use of a single unit, Central Detector Mast, placed on the top of a vehicle which contains the kill light and smoke cue, 360 degree retro reflectors, etc., and: they use a coaxial mounted laser projector instead of the laser being mounted inside of the gun tube. They also have a family of antitank weapon simulator systems. Their MARTAC III, which we didn't discuss, is being proposed as the TWGSS solution.

Anti-cheating is a major design effort.

It does not appear, from our discussion, that Marconi has actually produced a significant number of their systems. This is clouded because of the use by UK forces and selling the system to others that don't wish to be identified.

Projection of Future Technology:

Today's technology is limited by the performance of simulation laser scan system to find the target and provide accurate position location within weapon time on target. (This is due to future weapons with longer range, higher velocity movements, and greater accuracy.)

New eye safe laser systems will come into use with longer wavelength (1.55 microns). These will provide more power (1000 times). The use of CO2 laser which would need cooled detectors does not appear to be a solution (this could be an area needing more technology work--how about a solid state electrically cooled detectors).

Image processing technology may provide with IR systems a completely different technical approach for simulation.

The fire control system will be integrated with the training system, as is done with the Weston Simfire.

They view artillery simulation being accomplished using the target observer (FO) as the operator of the artillery simulation system. This system would be synthetic to the person operating it, and probably laser based. For example, the FO's field glasses are replaced with a training set that is equipped with a scanning laser system to project into the target area the simulation of artillery fire. With an image system the fall of shells could be simulated also into the field glasses. Rangefinding for the FO could be included for simulation data if the targets had retro-reflectors. Note that this will require miniature low power electronic systems.

Voice synthesized information appears to be a good way to communicate data to the trainee, but soldier acceptance is considered a problem because many people think it is a gimmick.

Embedded devices for sight pictures and computations would be expected in the future. A positive benefit of embedded training equipment would be the use of the training electrical connectors as maintenance points.

If the real weapons systems develop toward remote (robot) vehicles, then training simulation will be incorporated into vehicle along with the real sensors that are needed.

Next generation systems would expect to cost only about $4000 additional for training equipment when most hardware and software is embedded with tactical systems; for stand alone training systems the cost would project to $50,000.

Summary of mines discussion:

This was a follow-up discussion as a result of contacts made at the ADPA Mines Conference 23 and 24 September 1986.

Marconi furnishes the training bar mine simulator to the British Army. (A *bar mine* is a new British device that has a long rectangular shape instead of the more conventional round or square shape--I don't know the reason for this shape.) These mine simulators are currently in production with 2,300 nonelectrical training fuses and 300 electrical. Apparently the British Army does two kinds of training: placing mine fields without anyone encountering them (simple fuse), and emplacement with forces encountering mines for which the sensors and cue signal need to be present (electrical fuse). They can reuse the electrical fuse. Note, the British AT bar mine does not have a US design equivalent.

They use the real fuse minus the detonator for the bar mine because the cost of a simulator electrical fuse was nearly the same as the modified real fuse (200 to 300 BP, about $400 US); I assume that the sensor system (multiple and counter) is the cost driver; this system is still needed for mine initiation during the "encounter" training exercise. The real, and

simulator fuses have a lithium battery with 10 year shelf life and about 6 months operational life. Thus, the bar mine can "safe itself" from lack of power. It appears that the British have learned from their Falkland mine problem that a mine *safed,* because it is without actuation power, is very desirable.

The simulator bar mine uses biodegradable exterior materials and sand filler so that in England the mine will decompose in about six months. (This would not be the case in dry climates such as at NTC or Ft. Hood, Texas.) Plalite Developments, Star Hill, Rochester, Kent, England, is the supplier of the biodegradable plastic case.

The Swedish FFV magnetic influence mine apparently has a training device being developed. These will be supplied to W. Germany.

WLD:wd

Distribution

xc:

| | |
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| S. Asplund | 125-177 TES File |
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| D. Griffin | 125-177 |
| G. Henry | 125-177 |
| A. Mark | 125-177 |
| D. Maynard | 125-112 |
| K. Ramohalli | Aero & Mech Dept, Univ of Arizona, Tuson, AZ 85718 |
| G. Wiker | 125-177 |

JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM
375-287-86
October 31, 1986

TO: Jack Battenburg

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Trip Report, Visit to Saab Training, Jonkoping, Sweden, October 13, 1986

Peter Isoz, Product Manager
Dr. Hans Robertson, President

Comments:

Saab Training started in the 1960's with instrumentation of towed targets for air-to-air live fire. Microphones were used to pick up impacts of incoming rounds. The system was too expensive to be practical at that time. Saab then developed pneumatic pop-up targets with return-fire noise generators. They currently build targets which use pyro and loudspeakers for cues and return-fire noise, primarily for training dismounted troops. Saab targets are used by the U.S. Army at Grafenwohr and Vilsek and by the Canadians at their live-fire range in Canada. Pyro devices for Saab equipment are built in Sweden by Nobel. The Saab BT-375D target system moves up to 30 mph on tracks and is portable; it is radio-controlled from transceivers in the firing area. They have worked on targets with laser detectors but nothing has been produced because, in their words, the U.S. Army is now waiting for TWGSS.

The three primary systems for precision gunnery in both force-on-force and gunnery training are:

| | |
|---|---|
| BT-41 | For tank to tank |
| BT-52 | For TOW |
| BT-53 | For ground to air (Bofors gun and RBS-70) |

Maximum range is determined by eye safety, the quality of the reflectors, and the sensitivity of detectors. The Saab systems will work to a distance of 6 km and all use GaAS 0.9 micron eye-safe scanning lasers.

When a simulated round is fired, the Saab BT-41 scanning laser generates a "flying volume" with an imaginary projectile at its geometric center. This flying volume, with a cross-section of 20 mils X 20 mils at 1 km, travels the trajectory of the imaginary projectile until it reaches a target as indicated by a return laser signal from a retro-reflector.

On the target vehicle, retro reflectors and laser detectors are normally mounted at a single location on top of the tank. Retro reflectors give 360° coverage; twelve laser detectors allow the target to determine impact angle to within 30°. The weapon laser transmits a "null" code until a return signal from the retro reflector matches the range at the target. At that time, the

weapon laser changes to a code indicating type of weapon and miss distance azimuth and elevation. The target computer computes probability of hit and kill based on target profile and impact point. Saab BT-41 gunnery simulation includes super elevation, target lead, projectile flight time, ranging of the target, and superimposes muzzle flash and fall of shot in the sight picture.

A large "flying volume", with a cross-section of 180 X 180 mils, is possible for application in the wide angle sighting done in counter air.

The Saab BT-41 system is expensive because it is completely self-contained and has its own inertial reference system to determine fall of shot, regardless of weapon motion after firing. Hull-mounted retro reflectors can be used to account for a target in defilade.

To get a feel for how the system works, we had the opportunity to fire the BT-41, in simulation of both TOW and a tank main gun at fixed and moving targets at 1 km and 3 km. It seemed easy to get hits.

Saab training equipment development has been funded internally; they do not take development contracts. Saab looked into MILES-type systems in 1975 but didn't pursue it.

The Swedish Army has been using the Saab BT-41 for five years. They do force-on-force exercises with a total of about 100 tanks for both sides. (Note: This seems like a lot, on the scale of NTC.). The Swedish Army only has 55 BT-41 systems. Availability has been 90% with maintenance costs 2% of acquisition cost. Saab has not supplied spare parts. The system can be mounted on a tank by the crew in 30 minutes.

German gunners train about 50% of the time in the degraded (iron sight) mode. Dr. Robertson stated that most good gunners don't use the fire control computer. The problem with computers is that they replace the human brain rather than assisting it.

First round kills should count more than first round hits. Hitting isn't always killing; gunners need to be taught to look and wait for the best shot before exposing their location by firing their weapon.

The use of suppressive fire should be minimized; it just tells the enemy where you are.

The BT-41 has been used for a weapon development tool in both Sweden and the U.S. The simulation system for the Bofors BILL, an ATGM in the Dragon class, was fielded before the weapon itself. BT-41 was used at Ft. Eustis to investigate factors in helicopter air-to-air combat.

Live fire is a good candidate for simulation because it is expensive and difficult to do because of all the hazards. The costs of high fidelity simulation, like Saab BT-41, will go down to the level of MILES in the future.

Range of airborne laser simulation systems is greater due to the absense of scintillation at altitude. The BT-53 simulation system for the beam-riding RBS-70 antiaircraft weapon has a range of 6 km.

Saab looked at area weapons and concluded the only practical appropach to simulation was through the use of precision position location systems on the targets. A ±50 meter accuracy would be required for simulated artillery and a ± 1 to 10 meter accuracy for mines.

Saab also considered the idea (as did Marconi) of artillery attrition by using laser transmitters located with the forward observers.

As targets become smaller, such as turretless tanks, precision gunnery becomes more important. Using broad beam lasers, such as MILES, and manipulating $P_k$ is not realistic. Lead angle and superelevation become more important with fast-moving targets.

Embedded training equipment would have a big impact on the use of fire control systems; currently they are awkward and not used by many experienced gunners.

A tactical advantage of embedded training equipment would be the ability to check things out just before entering combat. This would address the goal of training equipment which increases combat readiness immediately before combat.

In combat, a laser/retro system could be used to measure firing offset and thus upgrade the next round.

Combining weapon requirements and training requirements in the same specification greatly complicates the specification. How do you specifically describe what the training system is to do?

A retro reflector could be installed in some missile systems to provide data in a tactical situation.

How to train is the big challenge for the future. There is too much emphasis now on simulation hardware, rather than on the objectives of the training.

An important issue is man/machine integration, which is more complex than man/machine communication. The Air Force has done a better job of this but their job is easier: there is no terrain in the equation.

cc:

R. Beaudet
J. Bruman
N. Ferraro
D. Griffin
G. Henry
D. Maynard
G. Wiker

JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM
375-284-86
October 31, 1986

TO: Jack Battenburg

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Trip Report, Visit with the Kurt Eichweber Company, Hamburg, Germany October 15, 1986

Mr. Claus Loges - Sales Manager, Training Systems

Comments:

Kurt Eichweber developed the first laser engagement system, the Shot Simulator, in 1962; lasers had just been invented and the Shot Simulator used some of the first production lasers. The orginial need was for "tactical training", i.e., maneuver training, not gunnery simulation. In technical training, the engagement consists of simply putting a target under attack with resulting attrition; gunnery is not simulated. Following this, the German Army asked for a gunnery trainer because of problems they were having in that area. Gunners had difficulty with ranging but not with aiming (putting the crosshairs on the target). Therefore, duplex systems were developed so that ranging could be included in the simulation. Duplex systems use a cooperative target, with a laser retroreflector for example, to return information to the firing weapon.

In 1970, the German Army ordered 700 sets of the Talissi system for the Leopard I. The capability to range was more important at that time than having lots of detectors on the target for sophisticated attrition.

The early Shot Simulator systems used radio to return data for determining range. Tests at the German equivalent of Aberdeen, Meppen Proving Ground, showed range data error was +15 meters. In 1972 they switched to retroreflectors to improve ranging accuracy.

German gunnery in the Leopard II stresses only keeping the crosshairs on the target; therefore, only the quality of tracking is measured. Not done are other things like trying to anticipate what the target will do next.

A German organization known as the EABG makes technology studies for their army including, but not limited to, training needs. The Talissi system is used by EABG to test required combat capability for new tanks, developing the Leopard II from the Leopard I, now developing the Leopard III from the Leopard II.

Mr. Loges agrees with the philosophy of the Swiss Army: don't include other things in gunnery training, just train the gunner to keep the crosshairs on the target, no more, no less. He believes that the degraded mode gunnery training can be done more efficiently other ways, such as in a classroom simulator. The Swiss believe it is a mistake to train degraded mode gunnery with a sophisticated gunnery simulator. A $2M tank shouldn't be using iron sights. Including the capability for degraded mode gunnery requires a much more sophisticated stand-alone simulation system, such as the Saab BT-41, costing up to 3 times more.

Mr. Loges believes that training functions, maneuver and gunnery, must be handled separately. Avoid trying to specify an "Eieklegende", a single animal that is capable of giving eggs, milk, ham, and wool.

The Kurt Eichweber Company has been able to influence design of fire control systems to benefit training systems, providing training interfaces for example, through interaction with Hughes and Krupp for German Armor,and with Honeywell and Zeiss for Swiss Armor. Separate development of weapon and simulator systems leads to problems.

The Talissi system makes a decision with regard to the quality of gunnery the moment the gunner presses the trigger, since the gunner now has no further influence on the outcome. A separate decision is made at the time the round would arrive at the target with regard to the quality of target response (evasive action, etc.). Thus two separate outcomes are possible: a hit for the gunner if he does everything right, a miss for the target if it does everything right. This is an interesting idea but may only be important when low velocity ammunition is being used, when there is time for evasive action.

The German Army has bought about 800 Talissi systems for Leopard tanks. They have instrumented as many as 100 tanks in maneuver training with 6 tank platoons attacking 2 platoons. One evaluation test used 400 instrumented tanks.

Kurt Eichweber has built more than 700 Dragon Simulators for delivery to the Swiss and Dutch, among others. This simulator includes a recoil simulation device, obscuration of the sight at launch, and a large pyro flash.

The Israelis separate gunnery training from several levels of maneuver training. Their gunnery trainers are the simple "keep the crosshairs on the target only" type. The Israelis have Talissi weapon cue simulators and about 100 sets of MILES. Their tank training is three-step: 1) basic familiarization, 2) gunnery, and 3) different levels of maneuver training.

Because each German village has its own active shooting club, Mr. Loges doesn't think there will be a need for a rifle gunnery simulator in the German Army.

The Talissi system uses a 5-laser fiber optic transmitter/receiver for scanning. This may be the equivalent of laser scanning by optical means, an advancement over mechanical scanning.

They build their own TOW tube at a cost of about $4K each; Emerson, the tactical supplier, wanted $40K each.

A special retro-reflector has been used to return a different signal than is received; it was an attempt a friend/foe indicator.

We saw a man-worn harness with small helmet-mounted retro-reflectors, 3M reflective tape on the torso harness, and some Kurt Eichweber man-worn laser detectors.

Mr. Loges feels that the main problem for future TES is for proponents of combined arms training to define what they want to train. That is the problem, the technical solutions are not.

Mr. Loge's assessment of future TES challenges - higher accuracy sensors of various types, more computer power to result again in greater accuracy, less size and weight, and lower cost. Finally, more embedded equipment so that less is required of the simulators.

He feels that in large combined arms exercises, the problem is not gunnery but communications. Communications can be trained with only the leaders; the soldiers are not required.

Kurt Eichweber will be introducing new systems, in about three months, that use new technology, apparently something other than lasers.

cc:

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JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM
375-285-86
October 31, 1986

TO: Jack Battenburg

FROM: Jon Inskeep/Warren Dowler

SUBJECT: Trip Report, Visit with Giravions-Dorand, Suresenes, France, October 17, 1986

Wolfgang Szebrat, Regional Director, Bendix Europe
Jean-Claude Allard, Director General, Giravions-Dorand

Comments:

Giravions-Dorand employs about 250 people and had $20 million in training equipment sales in 1985. About 60% of their sales are export, i.e., outside the French Army. The company (Dorand) originally built helicopters, then in the early 1950's, helicopter simulators. In the early 1960's, they built trainers for manual launching of small guided missiles. From there they branched into laser-based engagement systems and now build three types of integrated training simulators:

1. A system for elementary tank gunnery training of individuals in a classroom. This type of system uses video CRT technology to display a small field of view to the gunner. An example is their DX201 trainer. 90 systems have been delivered, one for each French tank company; the French Army has about 1000 tanks. The limited field of view makes it unsuitable for helicopter training.

2. A "strap-on" system used on a weapon platform (tank or helicopter) for more advanced gunnery. The system operates through the weapon sight and uses either an actual target or a computer- generated image of a target displayed against the real terrain viewed through the weapon sight. This system is used with an uninstrumented target; it therefore does not do ranging. It can be completely independent of the fire control system on the weapon platform. An example is the DX150. This system uses electro-optics technology; 82 of these systems have been delivered, three for each tank battalion in the French Army.

3. Force-on-force simulators. These are also strap-on systems that may or may not be interconnected with the weapons fire control system, depending on the application. These systems require a cooperative target, i.e., one instrumented with laser detectors and retro-reflectors. A target can function as a gunnery target if it has only retro-reflectors. The French Army uses this type of system for both gunnery and force-on-force training. Mr. Allard, however, believes that gunnery should be done with the cheaper Type 2 system (i.e., a DX150). An example of this system is the DX 175; 350 have been delivered, 12 for each French tank battalion and some for helicopters. Typical French force-on-force exercises are as small as one platform against another and are probably never larger than company versus company.

All in all, Giravions-Dorand has built about 2800 simulation systems of all types.

The French Army does not do combined arms training, even tank versus anti-tank, because of the logistics and politics of mixing different battalions. In the French Army, nearly every soldier below NCO is a conscript, in for one year of service. During this single year, they progress from basic training all the way through force-on-force exercises. The French appear to have a very different training problem, and solution, for tank gunners from those of other armies.

Several years ago, 80 French Army trainees each fired 400 simulated training rounds before each fired one live round. 92% of the live rounds were hits. One year later, with no further training, each again fired one live round; the hits dropped to 75%.

Giravions-Dorand feels their capability to track a target, after a retro-relector is first hit, is unique. Error coordinates are not sent to the target until the time an actual shell would have arrived at the target. The system then continues to track the target until 20 data messages are sent from weapon to target. They feel this gives them high reliability in transmitting weapon ID, range, and error coordinate data to the target. The Saab system, for example, sends the data message 3 or 4 times. Only one target can be paired for each trigger pull. Attrition is determined at the target using vulnerability factors which vary over the entire target volume. Twelve or more laser detectors give impact azimuth within 30°. Laser operation to 4 km is normal and to 6 km under optimum conditions.

Engagement data is stored in both weapon and target in non-volatile electronic memory. The French Army has decreed no paper (printers) in a tank and no laser in barrels (too much vibration, too low reliability).

The French Army does not use live fire as training; they do it only as a test after various stages of training with simulators.

Giravions-Dorand is also working on computer-generated imagery (CGI) for gunnery training. We saw a prototype system that superimposes CGI reticle, targets, and hit cues on a real terrain image stored on video disc. The background can be panned up to 360° with the target and reticle images also moving; all three movements are independent. They are almost ready to have CGI targets disappear behind real obstacles in the background imagery. Another future capability is to have a CGI target follow a road in the background image. This work is being done with corporate funding.

Giravions-Dorand has built an "open cockpit" helicopter trainer using CGI imaging.

Mr. Allard gave an assesment of future TES problem areas:

1. Modularity. Systems will have to be made in common modules to reduce cost and provide systems for the wide range of future weapons. Modularity also allows for small numbers of systems to be put together to use in development of new weapons systems, something Giravions-Dorand has done in the past.

2. Programming Possibilities. Software will also have to be modularized as is hardware. This may require large computer capability.

3. Performance of Simulation Equipment. Great range (now up to 6 km) and accuracy (now within 0.17 milliradians) will be required to simulate new weapons. Later, however, Mr. Allard said he thought present accuracy should be sufficient through the 1995-2000 time frame.

4. Performance of New Weapon Platforms. Speed (presently 90 km/hr), acceleration (currently operating up to 3 G), and maneuverability of new weapon platforms will challenge simulation system performance. Engagement between fast-moving antagonists requires sophisticated knowledge of what the firer, the shell, and the target are doing during engagement.

Mr. Allard presented future challenges to TES technology: developing systems that simulate the combined arms battlefield even at the platoon level. Another challenge, even more difficult than developing technology: handling the human interface: developers of new TES must not lose sight of the fact that all of these systems are used by human operators.

Reliability of cable connectors is a continuing problem.

Mr. Allard is not a fan of embedded TES equipment. However, this may be due to the characteristic of the French government to award permanent responsibilty for a technology to a particular company; embedding TES in a weapon system may transfer responsibility out of the hands of Giravions and over to the weapon supplier.

cc:

R. Beaudet
J. Bruman
N. Ferraro
D. Griffin
G. Henry
D. Maynard
G. Wiker

# APPENDIX A

## SECTION 3

## COMMENTS ON CURRENT EXPERIENCE WITH MILES

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California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109
(818) 354-4321

JPL

September 12, 1986

PM TRADE
ATTN: AMCPM-TND-ET (Mr. Joe Thompson)
Naval Training Center
Orlando, Florida 32813

Dear Mr. Thompson:

JPL personnel have visited more than twenty-five Army commands in the course of interviewing Army training and combat personnel to determine needs for future Tactical Engagement Simulation (TES) systems. Reports for each of these trips have been written and distributed. Suggested TES needs are a major part of these reports and also, in a more organized format, make up the TES Prioritized Needs Questionnaire to be completed soon by JPL.

In addition to TES needs, JPL has received comment on topics which are probably outside the scope of the TES task. These have to do with current use of MILES, Army command attitudes toward use of TES in training, and a critique of Army policy. The importance of these comments is that they are some of the reasons why the present TES system, MILES, is not being utilized to its full effectiveness, a problem that will not be solved by just new technology. Although some of this comment does end up in TES reporting, much of it appropriately does not. However, the JPL TES task team feels that it is significant enough to warrant separate reporting to the Army.

The thougnts reported here are not based on isolated comments by a few individuals; they were universal enough to be considered a concensus.

Sincerely,

Jack Battenburg
SAWE Project Manager

JB:do

Attachment

(ATTACHMENT)

MILES

There is concern at JPL that some existing problems with MILES should not have to wait the arrival of the next generation TES to be fixed. Some interim upgrading is warranted. Examples are:

Helmet Harness. The fit on the old steel pot is poor and the fit on the new Kevlar helmet, despite an improvement to the Velcro adjustment, is worse. Perhaps part of the problem is insufficient instruction, but the result is that the harness comes off easily and is often lost. Many times it is taken off just to prevent loss. The weight and off-center placement of the electronics box causes considerable discomfort during long exercises.

Torso Harness. The torso harness is not compatible with the rucksack which is worn often. Under the rucksack, the electronics box makes the harness uncomfortable to the point of being painful, and unable to be engaged. Worn over the rucksack, the harness flops around, since it cannot be secured, and makes removal of the rucksack, in simulated combat, cumbersome.

Torso Harness. In the turret of a vehicle, especially the Bradley IFV, the chance of snagging the harness is common enough to make it potentially dangerous and unsafe. Even getting in and out of the back of an Infantry Track is a problem. Many commanders do not permit the wearing of the harness in armored vehicles as a safety measure. Without harnesses, crew members cannot be attrited.

Torso Harness. There is universal dislike for the cross-chest strap by troops wearing the harness in field conditions. It's called a "choker".

MWLD. There are few if any written instructions, procedures, or illustrations on how to wear MWLD equipment in conjunction with combat gear.

MWLD. Batteries come out of the electronics boxes too easily on the helmet and torso harnesses. Normal wearing-out of the threads on the battery box cover retaining screw is part of the problem. When this happens, it is necessary for the player to find a controller to be reset.

Keys. There is universal dislike for MILES keys. They are too big a temptation for counterfeiting, which can be easily done. They are easy to lose, and soldiers are often required to pay for them, between $6 and $40.

MILES TOW. Using the fixed 10-second hold-on time is considered very unrealistic, especially when firing TOW at short or long ranges. The result can be either too many or too few kills.

OH-58 MILES. The cockpit kill indicator placement on the OH-58 is potentially dangerous because it blocks part of the pilot's view.

OH-58 MILES. There is a MILES strap that covers the wire cutter, reducing its effectiveness.

MSTS. The new MILES System Test Set (MSTS), which replaces the M144 test set, is a step in the wrong direction. It is too complicated for most soldiers to use and usually ends up gathering dust in TASC. This is unfortunate because fault isolation to the component level is very important in keeping instrumented exercises going.

MILES CLS. Contractor support is very dependent on the personal intiative and effort of the contractor personnel in CLS. At the present time, Loral enjoys a very good reputation with the Army worldwide. High praise was given the CLS representatives covering Fulda and Berlin, in particular.

## COMMAND

Cheating. It is an exceptional case where either punishment (Article 15) or education ("you're only hurting yourself") has been effective in curbing cheating. Cheating is widespread despite assurances from senior officers that they are able to control it. Junior officers and enlisted personnel freely admit it.

Cheating. Equipment has been turned in to TASC modified to the extent that it is apparent that it was done uniformly on a squad-level basis.

Cheating. "We're coming up to the bridge site now, so everybody turn off their MILES." Quote from a company commander.

Cheating. It is common practice in an ARTEP to keep resurrecting soldiers (requiring controller cooperation) until the objective is achieved and the ARTEP is therefore passed.

Training Benefit. On one MILES-equipped exercise at Doughboy City, the MOUT training area in Berlin, one unit spent 36 hours of a 48-hour exercise filling,emplacing, and then emptying sandbags. Not only are sandbags not expected to be used in combat there, this left little time for force-on-force training with MILES.

Training Benefit. Troops in Berlin, in their own words, dread going to Doughboy City. It takes them a week to clean up the area after a 3-day exercise.

MILES Training. Few units take any time to train the use and limitations of MILES, how it is installed, or how to conduct fault isolation in case of operating problems. Comprehensive training documentation, available in TASC, is seldom used. Offers to conduct MILES training by TASC personnel get little acceptance.

Controllers. This important function is too often left to poor quality or junior personnel as it is felt to be a waste of time and the best people are wanted in the maneuver forces so as to best accomplish the mission.

Controllers. Controllers are commonly used only as safety officers, not to control the exercise or to observe from the standpoint of being an effective evaluator after the exercise.

## POLICY

Issue. Army policy of issuing enough MILES to equip one battalion in each division has resulted in not enough MILES to support many training opportunities. This is due primarily to the amount of time it takes to remove, inventory, refurbish, issue, and install MILES when transferring it from one unit to another. This usually takes more than a week.

Accountability. The combination of Army policy of accountability with the violent environment in which MILES is used, and the ease in which some MILES hardware comes off the player, results in improper or under utilization. Soldiers have been charged from $6 to $40 for lost MILES keys, $200 or more for lost helmet harnesses, and $400 or more for lost rifle transmitters. It is not unreasonable to expect some of these items to be lost in simulated combat, especially at night, and especially if there are design problems with their attachment. The result is unrealistic training. Soldiers take off helmet harnesses to keep from losing them. They move through cover not as they would in combat, but to keep their eyes on their MILES. "Some people are so paranoid at losing stuff that MILES loses its effectiveness". In discussing the need for a hand grenade simulator it was pointed out that "if something is accountable, people will throw it only where they know it can be found".

Issue. Units receiving the HMMWVs are instrumenting them with MILES kits for the M113s. But since they are losing their M113s, somebody thinks they no longer need the MILES kits, so they are now losing the MILES and have nothing to use with the HMMVWs.

OPFOR Threat. Upgrading of MILES isn't keeping up with the latest Soviet weaponry because the performance of that weaponry is classified. The result is that our troops are fighting the threat as it was 10 years ago. At NTC, M1s are fighting T72s, or maybe even T62s. In armor battles, for example, Soviet tanks will have greater range, less vulnerability and the ability to shoot on-the-move versus what is facing rotational units at NTC today.

Realism. The Army does not train the things that make tactics difficult to execute. EMI is seldom played; when effective jamming techniques are added to an exercise everything comes to a halt. Casualty evacuation is rarely part of an exercise; maneuver essentially stops when evacuation becomes part of the exercise. In REFORGER, air superiority is assumed; it is hardly likely to

happen, and tactics will have to be entirely different without it. Although use of IFF is apparently required under Army policy for Counter Air, it is almost never implemented in exercises, and soldiers are uncertian if it will be practical in combat.

Realism. Quote: "Don't make SAWE too big a killer; we don't want to demoralize troops about how horrible artillery really is."

# APPENDIX B

## THE PRIORITIZED NEEDS SUMMARY


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## SECTION 1

## OVERVIEW

### 1. The Prioritized Needs Summary Questionnaire

Based on the findings of the interviews with trainers at the twenty-six Army installations visited during the prior phase of this study, JPL generated a Prioritized Needs Summary (PNS) Questionnaire. The objective of this questionnaire was to assess the needs and the priorities of the Army for future generation TES to be fielded in the 1995-2000 time frame, i.e., to verify the TES needs that JPL heard during the troop interviews.

A trip report was written for each visit to an Army installation to provide a record of the Army comments on present and future generation TES (see Appendix A). Each of these reports was carefully reviewed at the time the PNS Questionnaire was developed to ensure that all the Army interests in TES were included in the questionnaire. Because of this extensive background, the questionnaire is both comprehensive and complete. A copy of the questionnaire, with the averages of the responses obtained and representative comments from Army reviewers added, is Section 2 of this appendix.

The issues presented in the questionnaire were grouped into categories which dealt with all aspects of TES that would impact its technology development. These included:

a. Location and types of training sites using TES.

b. Size of organizational units to be trained by TES.

c. The players and weapons to be instrumented.

d. The functions of the systems to be simulated and how closely these functions must be simulated.

e. The visual cues required for different systems.

f. Administrative requirements for running an exercise.

g. Physical characteristics of the TES equipment.

The respondents were requested to give a priority rating of (0) through (5) for each question. The rating system was chosen so that the results could easily be averaged to reflect the overall need of a given feature. One rating (5) was offered to identify those items that might actually be undesirable in that they could result in negative training. A rating of (0) was requested when the respondee was not interested or knowledgeable; any such responses were not used in determining the numerical averages. In addition, respondents were given the opportunity to add or amend comments and questions. The rating scale definitions given were:

| | | |
|---|---|---|
| (1) | *Mandatory* | Don't buy a TES system without it. |
| (2) | *Recommended* | Training effectiveness would be degraded without it. |
| (3) | *Useful* | But not worth adding to TES system cost. |
| (4) | *Not useful* | Has little or no training benefit. |
| (5) | *Undesirable* | Don't want; may result in negative training. |
| (0) | *Not rated* | Cannot assign a priority rating to this item as I am not qualified, not interested, don't know, etc. |

The questionnaire was sent to the Future Generation TES Study Advisory Group (SAG) for comment and approval prior to Army-wide distribution. The comments by the SAG were then incorporated into the final document.

The questionnaire was then sent to the Army Training Support Center (ATSC) TES office at Ft. Eustis for distribution through Army command channels to appropriate Army organizations for their input. The 135 responses are listed in Table 1.

Different organizations handled the questionnaire in different ways. Some reproduced the questionnaire so they could be filled out by various elements in their organization. For example, First Army returned 50 copies of the questionnaire. Others returned only one copy, presumably averaging responses from several organizations within a command. Unfortunately, a few units did not respond at all; the 135 responses came from twenty-three organizations. It was obvious that most of the respondents had answered the questionnaire conscientiously. However, some were answered by individuals of varying ranks and experience. Some were answered by non-commissioned officers, others by combat and field grade officers. JPL and ASTC had not considered before distribution the level at which these questionnaires should be answered. Thus, a correlation of results with sets of respondents is not feasible; however, agreement on the prioritization of the top priority items is good, as indicated by the small dispersions.

Table 1. PNS Questionnaire Responses

| NUMBER OF RESPONSES | ORGANIZATION |
|---|---|
| 5 | USA Engineer Center, Ft. Belvoir |
| 6 | USA Infantry Center, Ft. Benning |
| 1 | USA Air Defense Center, Ft.Bliss |
| 12 | USA Armor Center, Ft. Knox |
| 5 | USA Combined Arms Center, Ft. Leavenworth |
| 7 | USA Aviation Center, Ft. Rucker |
| 1 | USA Field Artillery Center, Ft. Sill |
| 1 | USA Europe and 7th Army, Germany |
| 4 | FORSCOM Headquarters |
| 1 | I Corps Headquarters |
| 1 | 6th Infantry Division |
| 19 | 7th Infantry Division |
| 1 | 9th Infantry Division |
| 1 | XVIII Airborne Corps |
| 5 | III Corps |
| 6 | 1st Cavalry Division |
| 50 | First U.S. Army |
| 1 | Second U.S. Army |
| 4 | Fourth U.S. Army |
| 1 | Fifth U.S. Army |
| 1 | Sixth U.S. Army |
| 1 | National Guard Bureau |
| 1 | Unable to identify |
| 135 | TOTAL |

2. The Prioritized Needs Summary

The results from the 135 questionnaires were tabulated by computer, using LOTUS 1-2-3 Version 2.01. Each question was entered into the program on a single line. The response from each organization was entered in a column for that organization, opposite the question. The responses were tabulated as a number from (1) to (5), corresponding to the numerical rating scale used in the questionnaire. Questions answered by a (0) or left blank were also left blank in the tabulation, so that they would not be included in the number of responses to that question and thus decrease the question priority in the results. The initial tabulation was summarized by obtaining the average value of the numerical priority rating and the standard deviation for each and every question.

However, it was unfair to award any organization more than one vote because it had responded with more than one copy of the questionnaire. (For example, First Army should not have fifty times the weight of Third Army

which returned only one questionnaire.) Thus, the responses within each organization surveyed were independently averaged; this average value was then used as the single response for that organization. The average was rounded off to one decimal place, e.g., 2.1. The results obtained for each of the organizations were then processed, tabulated, and averaged.

These early results of the PNS were presented to the SAG for their suggestions and comments prior to completion of the Prioritized Needs Summary. At the time not all questionnaires had been returned. The SAG recommended obtaining responses from Third Army, which responded later, and the Chemical School. The SAG suggested making comparisons between various types of organizations, breaking down the reponses as:

a. Centers and Schools
b. Active combat units
c. Reserves and National Guard
d. Heavy and light units.

After the SAG meeting, responses were obtained from a few more organizations. Twenty-three organizations responded in all. Further analysis of the results was made by averaging the results from the different types of Army units as suggested by the SAG. Tabulations were obtained for the schools (seven responses), for the active units (nine responses), for the reserve components (seven responses) and for USAEUR (one response). Unfortunately, there were no responses from many of the light units so the last comparison (d) could not be done. The differences between the tabulations for the other three categories proved to be slight. The results of these tabulations are included as Section 3 of this appendix.

The final analysis gave each of the twenty-three organizations one equal vote. The tabulation of these results is included as Section 4 of this appendix. The summary results are reported by filling in the questionnaire with the averages of the Army rankings, as depicted on the questionnaire in Section 2 of this appendix.

# APPENDIX B

## SECTION 2

## PRIORITIZED NEEDS SUMMARY QUESTIONNAIRE

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PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (6) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

A. TYPE OF TRAINING. Please indicate, using the rating scale above, the importance to your organization of the types of training for which TES should be developed.

1. Maneuver . . . . . (Mandatory)
2. Gunnery . . . . . (Recommended)
3. Command/Leader . . . . . (Recommended)
4. Command and Control Staff. . . . . (Recommended)
5. Crew Skills . . . . . (Recommended)
6. Technical Skills . . . . . (Recommended)
7. Combat Support . . . . . (Recommended)
8. Combat Service Support . . . . . .(Useful)
9. Multi-Echelon. . . . . (Recommended)
10. With Foreign Units . . . . . .(Useful)
11. MOUT . . . . . (Recommended)
12. Other (Please list under comments) . . . . . .( )

COMMENTS: A flag was raised immediately concerning simulation within gunnery. Recoil, wind, etc., duplication is critical but comments indicated TES could provide good practice for weapons they don't shoot, significant strides for reserves in tank gunnery, and a true need when considering budget, time and facility shortages.

Training in air-to-ground maneuver was specifically identified as was advanced combat skill in multiship operations in air cavalry/attack helicopter scenario.

The application of TES to CS and CSS, as they relate to maneuver, was noted as long overdue in light of increased interest in rear operations.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

B. LOCATION OF TRAINING. Please indicate, using the rating scale above, the importance to your organization of the type of location where TES should be used:

1. Theater . . . . . (Reforger-type exercises) . . . . .(Recommended)
2. Major training centers . . . (such as NTC) . . . . . .(Mandatory)
3. Smaller training centers . . (such as JRTC) . . . . . .(Recommended)
4. Dedicated test centers . . . (such as Ft. Hunter-Liggett). . . (Recommended)
5. Large home stations . . . . (such as Ft. Hood and Ft. Lewis). . .(Mandatory)
6. Smaller home stations . . . (such as Ft. Carson) . . . . . .(Mandatory)
7. Schools . . . . . .(Recommended)
8. National Guard Armory. . . . . .(Recommended)
9. Army Reserve Training Center Area. . . . . .(Recommended)

COMMENTS: All comments tended to show a desire for TES to be based at "smaller", more "local" facilities. This was not expressed to the exclusion of TES at larger stations and centers. The ability to have use of TES on a regular basis at a company level at smaller home stations was even expressed as a great concern.

Reserve and National Guard comments identified small local training areas to be of importance and stressed the desirability for TES training at their respective locations. At a minimum, comments indicated a need to establish some priority for Reserve and NG in funding and thus availability. It was noted that the Reserve and NG comprise half of Army combat arms, but systems are developed for the active component environment and adapted for the reserves with varying degrees of success. Comments from centers and school generally supported the need to accomodate Reserve and NG training at their locations or through integration with nearby active units.

With budget constraints straining the ability to train with actual vehicles or training ammo, plus range time constraints, any TES system must support training world-wide. Also noted was the need for the system to be able to be used not only anywhere, but also in any environment.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

C. UNIT SIZE. Please indicate, using the rating scale above, the importance to your organization of the unit size for which TES should be used in future training:

1. Individual . . . . . .(Recommended)
2. Crew/Team . . . . . .(Recommended)
3. Squad/Section . . . . . .(Mandatory)
4. Platoon/Troop . . . . . .(Mandatory)
5. Company . . . . . .(Mandatory)
6. Battalion . . . . . .(Recommended)
7. Battalion Task Force. . . . . .(Recommended)
8. Regiment/Brigade. . . . . .(Recommended)
9. Division . . . . . (Useful)
10. Corps/Echelons above Corps. . . . . (Useful)

COMMENTS: Company/troop elements were indicated to have priority because they represent the smallest integral unit that would be trained. This consideration was not universal but company-level TES application was most widely proposed.

Battalion Task Force was identified as the echelon where synchronization of combat power occurs and thus should receive priority. (Most training areas can support BnTF in maneuver area.) In fact, TES at NTC/CMTC must support Regiment/Brigade and larger exercises.

Aviation must avoid using units smaller than company-size in separate force-on-force exercises. Specifically, doctrine emphasizes battalion-size for attack helicopters.

Consideration should also be given to the fact that battalion and larger exercise require additional instrumentation to control and conduct OARR.

It should be noted that the comments did not imply that TES should not be used in training smaller units. Comments did emphasize the need for TES to accommodate large scale exercises.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

D. TYPE OF INSTRUMENTED PLAYER. Please indicate, using the rating scale above, the importance to your organization of the types of players that should be instrumented (i.e., capable of engaging or being engaged) with TES systems:

1. Dismounted soldiers . . . . . .(Mandatory)
2. Crew-served ground weapons (dismounted) . . . . . .(Mandatory)
3. Armored vehicles . . . . . .(Mandatory)
4. Non-armored vehicles . . . . . .(Recommended)
5. Air defense artillery . . . . . .(Recommended)
6. Self-propelled howitzers . . . . . .(Recommended)
7. Towed howitzers . . . . . .(Recommended)
8. Attack helicopters . . . . . .(Mandatory)
9. Scout helicopters . . . . . .(Recommended)
10. Transport helicopters . . . . . .(Recommended)
11. Surveillance aircraft . . . . . .(Recommended)
12. Low speed aircraft . . . . . .(Recommended)
13. High speed aircraft . . . . . .(Recommended)
14. Combat service support vehicles . . . . . .(Recommended)
15. All platforms/vehicles on the battlefield . . . . . .(Recommended)

COMMENTS: A summary of the comments could be "the more the better". Specifically, any soldier, system or vehicle on the battlefield forward of FEBA should be fair game and killable.

With respect to individual platforms/players, there were some specific comments beyond the "more is better" statement. For example: non-armored vehicles should be instrumented if a combat vehicle, i.e., HHMWV, TOW; cav scout wheeled vehicles for more realistic field problem; all types of helicopters and fast and slow mover type aircraft for counter-air battle; and, laser designators.

A third concept in instrumenting (or design) is to make sure that TES has the ability to engage targets that would normally be engaged by a particular weapon system.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

E. TYPE OF WEAPONS. Please indicate, using the rating scale above, the importance to your organization of the type of weapons that should be simulated in a future TES system:

1. Pistol . . . . . (Useful)
2. Rifle . . . . . .(Mandatory)
3. Machine gun . . . . . .(Mandatory)
4. Hand grenade. . . . . .(Recommended)
5. Grenade launcher. . . . . .(Recommended)
6. Explosive charges . . . . . .(Recommended)
7. Mines, conventional . . . . . .(Recommended)
8. Mines, scatterable. . . . . .(Recommended)
9. Mines, chemical . . . . . .(Recommended)
10. Mortar. . . . . .(Recommended)
11. Tank/fighting vehicle weapons . . . . . .(Mandatory)
12. Air defense . . . . . .(Recommended)
13. Antitank guided missiles. . . . . .(Mandatory)
14. Artillery, conventional . . . . . .(Recommended)
15. Artillery, rocket . . . . . .(Recommended)
16. Artillery, chemical . . . . . .(Recommended)
17. Aircraft bombs/cluster bombs. . . . . .(Recommended)
18. Air-to-air. . . . . .(Recommended)
19. Air-to-surface. . . . . .(Recommended)
20. Directed energy . . . . . .(Recommended)

COMMENTS: Weapons specified in the comments included: 107 mm mortars and larger; .45 cal; M-3 sub-machine gun; M16 and M203 rifles; all types of mines; and, all OPFOR armor and OPFOR killers.

One comment, related more to an exercise than to a specific weapon system, stated that everyone must have a kill instrument that is equal in capability to the assigned weapon. This comment implies that all weapons capabilities are represented in TES.

TES of directed energy should be developed and available when such weapons are introduced into the force. (This concept of co-introduction of weapon/TES-component could be applied to other weapons and platforms.)

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

F. SMART WEAPONS. Please indicate, using the rating scale above, the importance to your organization of the following, in the playing of 'smart weapons' (such as Hellfire, Copperhead, SADARM, FOG-M, etc.) on the future TES training battlefield, of simulating:

1. Weapon assembly and set-up . . . . . .(Useful)
2. Weapon checkout. . . . . .(Useful)
3. Loading. . . . . (Recommended)
4. Target acquisition . . . . . (Recommended)
5. Aiming and tracking. . . . . (Mandatory)
6. Firing . . . . . (Mandatory)
7. Weapon firing signatures . . . . . (Recommended)
8. Target area effects. . . . . (Recommended)
9. Real-time casualty assessment. . . . . (Recommended)
10. Integration of all of the above. . . . . (Recommended)

COMMENTS: Time fidelity was mentioned. The time it takes to carry out the activities listed in the PNS (set-up, loading, etc.) should approximate real-time for the weapons being simulated. With respect to weapon assembly and set-up, one comment suggested that we allow the level of technology to suit the task; if a GTA will suffice, developing an overly detailed training system should not be pursued.

There was a suggestion that battlefield effects of similar OPFOR systems would be useful with OPSEC related training being a benefactor.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

G. SIMULATED GUNNERY. Please indicate, using the priority rating scale above, the importance to your organization, in future TES, of the replication of the following gunnery characteristics.

1. Shoot-on-the-move . . . . . (Mandatory)
2. Shoot at moving targets . . . . . (Mandatory)
3. Target lead . . . . . (Recommended)
4. Wind effects. . . . . (Recommended)
5. Selection of ammunition . . . . . (Recommended)
6. Ranging . . . . . (Recommended)
7. Ballistics. . . . . (Recommended)
8. Simulation of weapon hold-on-target time. . . . . (Recommended)
9. Provide for the effects of countermeasures, including evasive action . . . . . (Recommended)
10. Burst-on-target cue . . . . . .(Recommended)
11. Tracers . . . . . (Recommended)
12. Firing cues and signatures. . . . . (Recommended)
13. TES to supplement live fire gunnery training. . . . . (Recommended)
14. TES to replace live fire gunnery training . . . . . .(Useful)
15. Provide same system operation and problems (switchology, errors, etc.) . . . . . (Recommended)
16. Simulation of recoil. . . . . (Recommended)
17. Simulation of loading rounds (tank main gun, artillery, mortars). . . . . (Recommended)
18. Zero or boresight of weapon . . . . . (Recommended)
19. Dry-firing of weapon. . . . . .(Useful)
20. Real-time feedback to gunner after a miss . . . . . (Recommended)

COMMENTS: Shoot-on-the-move should be limited to the actual weapons systems capabilities.

That one can't or shouldn't completely replace live fire gunnery was stated more than once but the comment was usually tempered. It was recognized that TES gunnery could save money compared to live gunnery. Also, weapon

G. SIMULATED GUNNERY (COMMENTS, continued)

technology may be such that live fire may not be accomplished safely. It was noted that live fire substitution would require exact duplication. One comment emphasized it this way, "You don't want a sm(?) to train TES, then go to war and the first round he shoots scares the hell out of him".

The live fire supplement UCOFT for M1/M2 is in effect and the need exists for other systems. In general, current engagement simulation is so unrealistic that if half of the suggested improvements go into the next generation TES, the results will be earth shattering.

(See page A, Type of Training, for other comments concerning gunnery.)

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

H. EMBEDDING. Please indicate, using the rating scale above, the importance to your organization of the TES capability being permanently embedded in the weapon, vehicle, or aircraft, instead of being added on for training exercises.

( ) If you feel that embedding of training systems in tactical equipment is not desirable, please check this space and go on to the next section.

1. Small arms . . . . . .(Useful)
2. Crew-several weapons . . . . . (Recommended)
3. Armored vehicles . . . . . (Recommended)
4. Non-armored vehicles . . . . . .(Useful)
5. Artillery. . . . . (Recommended)
6. Helicopters. . . . . (Recommended)
7. Aircraft . . . . . (Recommended)
8. Provide engagement rehearsal capability in a wartime environment. . . . . (Recommended)

COMMENTS: Embedding TES components was seen as a way to provide: flexibility in training (anytime, any place), capability to rehearse engagement, and a method to solve any availability problem.

On the negative side, some comments identitifed reasons for not preferring or at least being skeptical about such a capability. These include: vehicle power supply limitations; additional complications in training by adding more maintenance and training demands specifically for the training system; equipment control mechanisms (switches) wear out faster causing more combat system down-time; and concern of adding weight or anything, for that matter, that is not needed in any weapon system.

There was some qualified support for embedding. As long as the system doesn't require a great amount of maintenance and associated down-time, there may be greater support. Additionally, the training system and the

H. EMBEDDING. (COMMENTS, continued)

real system should be separated to the extent that an inoperable training system would not affect the real system; furthermore, an inoperable real system would shut down the training component.

One commentator thought embedded weapons would be great for issue and use at training sites but that embedding the assigned weapons could not be endorsed.

Alternatives such as standardized power supply connector, data link port/ antennae mounts, and emphasizing easy addition and deletion in design as solutions make the complexity and costliness of embedding less desirable.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

1. AIR DEFENSE. Please indicate, using the rating scale above, the importance to your organization of the simulation of air defense as follows:

1. Provide TES which realistically replicates air defense gunnery.(Recommneded)
2. Provide instrumented RPVs (subscale) as shoot-back targets. . .(Recommended)
3. Instrument helicopters for air defense exercises. . . . . .(Recommended)
4. Instrument low speed (A10) aircraft for air defense exercises .(Recommended)
5. Instrument fast movers (F16s) for air defense exercises . . . .(Recommended)
6. Realistically simulate air defense missile systems . . . . . .(Recommended)
7. Include capability to simulate incoming attacking targets . . .(Recommended)
8. Include IFF in all engagements. . . . . .(Recommended)
9. In maneuver exercises, air defense should be simulated out to a range of:
   1 km. . . . . .(Recommended)
   10 km . . . . . .(Recommended)
   The maximum range of available weaponry . . . . . .(Recommended)
10. Include the effects of Aircraft Survivability Equipment in determining probability of hit. . . . . .(Recommended)
11. Provide realistic VISMODs for threat helicopters and aircraft .(Recommended)
12. Provide video coverage to support After Action Reviews. . . . .(Recommended)

COMMENTS: Air defense should be conducted out to a maximum range of threat weaponry. Alternatively, a 1 km range could be considered for slow movers and a 10 km range for fast movers.

Fratricide is a big killer and IFF must be forced on everyone to make it work. But, IFF applied to TES should be limited to the capabilities of the host vehicle. The use of IFF in RPV could present a security problem, if RPV goes out of control, and thus should not be included.

An alternative to threat helicopter and aircraft VISMODs could be the purchase from Chad/Israel.

. AIR DEFENSE. (COMMENTS, continued)

TES must provide for air defense activities of non-ADA units (small arms, machine gun engagements) and true combined arms engagement training.

A good TES system to determine actual aircraft kills is drastically needed.

One respondent considered videotape-supported AARs as probably the most important item within this topic.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

J. ARTILLERY & MORTARS. Please indicate, using the rating scale above, the importance to your organization of the sim.`ation, at the battery, of artillery and mortars in the future TES system. The next section deals with the effects of these weapons in the target area.

1. Loading rounds - procedures . . . . . (Recommended)
2. Loading rounds - weight of round. . . . . (Recommended)
3. Loading rounds - loading time fidelity. . . . . (Recommended)
4. Laying the weapon . . . . . (Recommended)
5. Firing the weapon - procedure . . . . . (Recommended)
6. Firing the weapon - recoil. . . . . (Recommended)
7. Firing the weapon - flash, bang, and smoke. . . . . (Recommended)
8. Adjustment of fire. . . . . (Mandatory)
9. Target area cues for Forward Observer . . . . . (Recommended)
10. Use of Battery Computer System (BCS). . . . . (Recommended)
11. Use of TACFIRE. . . . . (Recommended)
12. Simulate/replicate entire command and control network . . . . (Recommended)
13. Simulate loss of communication. . . . . (Recommended)
14. Defense of area . . . . . (Recommended)
15. Counter battery fire. . . . . (Recommended)
16. Direct fire . . . . . (Recommended)
17. Improved munitions (i.e. Copperhead). . . . . (Recommended)
18. Selection, use, conservation, and resupply of ammunition. . . (Recommended)

COMMENTS: One artillery group thought all items, except weight of round and recoil, were mandatory. One individual highlighted his feeling that any action through the TES system to improve adjustment of fire during maneuver exercises is long overdue.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

K. ARTILLERY & MORTAR EFFECTS. Please indicate, using the rating scale above, the importance to your organization of the simulation of the effects, in the target area, of artillery and mortars in the future TES system.

1. Flash of incoming rounds . . . . . (Recommended)
2. Bang of incoming rounds . . . . . (Recommended)
3. Smoke of incoming rounds . . . . . (Recommended)
4. Simulated ground burst . . . . . (Recommended)
5. Simulated air burst. . . . . (Recommended)
6. Attrition of vehicles. . . . . (Recommended)
7. Attrition of vehicle crews . . . . . (Recommended)
8. Attrition of dismounted troops . . . . . (Recommended)
9. Suppression. . . . . (Recommended)
10. Simulation of damage to buildings. . . . . .(Useful)
11. Simulation of damage to structures (bridges, roads, etc.). . . . . .(Useful)
12. Real-time casualty assessment. . . . . (Recommended)
13. Adjustment of fire . . . . . (Recommended)
14. Round-for-round simulation . . . . . (Recommended)
15. Surprise . . . . . (Recommended)
16. Time fidelity for receipt of indirect fire . . . . . (Recommended)

COMMENTS: The greater the realism, by using smoke, bang and flash of incoming rounds, the better the training. It was suggested that flash and smoke of incoming rounds could be provided by having the controller use a hand-held device. One artillery group thought all items were mandatory except for round-for-round simulation.

The capability of TES to determine kill probability for remote sites, such as ADA, is needed.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

L. MINES. Please indicate, using the rating scale above, the importance to your organization of the following, for the simulation of land mine warfare in future TES systems:

1. Replicate the size of the mine being simulated. . . . . .(Recommended)
2. Replicate the weight of the mine being simulated. . . . . .(Recommended)
3. Replicate the trip mechanism of the mine being simulated. . . .(Recommended)
4. Reproduce detection characteristics of the mine being simulated(Recommended)
5. Simulate mines on a one-for-one basis . . . . . .(Recommended)
6. Simulate mines on a generic basis for AT or AP. . . . . .(Recommended)
7. Simulate the attrition and casualty effects of each individual mine . . . . . .(Recommended)
8. Simulate only the overall effects of the minefield. (e.g., obstacle) . . . . . .(Recommended)
9. Provide for simulating the logistics (such as supply) of mines. . . (Useful)
10. Provide for simulating emplacement of mines . . . . . .(Recommended)
11. Provide for simulating arming of mines. . . . . .(Recommended)
12. Provide for simulating disarming and retrieval of mines . . . .(Recommended)
13. Provide for simulating breaching operations . . . . . .(Recommended)
14. Provide for simulating breaching weapons (fuel/air mixture, explosives) . . . . . .(Recommended)
15. Provide real-time casualty assessment on vehicle. . . . . .(Recommended)
16. Provide real-time casualty assessment on personnel. . . . . .(Recommended)
17. Attrition of any player . . . . . .(Recommended)
18. Attrition of only major weapons . . . . . (Useful)
19. Mine reuse after using (refurbishment). . . . . .(Recommended)
20. Threat mine warfare . . . . . .(Recommended)

COMMENTS: Most comments were restatements of the listed choices, underscoring desires for specific replications in areas such as size, weight, trip mechanism, and arming simulation. One comment suggested that if simulation is not close to the real thing, it wouldn't be worth the time or money; another comment proposed generic AT and AP mines and simulating only overall effects of the minefield as minimum requirements.

Leaving assessments to controllers and players was suggested.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

M. NUCLEAR/BIOLOGICAL/CHEMICAL. Please indicate, using the rating scale above, the importance to your organization of incorporating the following into the future use of TES:

1. Training intended for individual soldier NBC skills alone. . . (Recommended)
2. Training intended for NBC team skills (decon, survey, etc.). . (Recommended)
3. NBC training exercises simulated separately from other training. . .(Useful)
4. Integrated N, B, and C training exercises. . . . . (Recommended)
5. Use of notional units and NBC events outside of training area. . . .(Useful)
6. Different NBC simulant realism according to the level of the exercise . . . . . (Recommended)
7. Use of NBC warning and reporting systems and procedures. . . . (Recommended)
8. NBC monitoring and survey teams at the battalion/task force and company/team levels. . . . . (Recommended)
9. NBC simulation devices, used along with tactical equipment, able to be used by any individual soldier. . . . . (Recommended)
10. NBC simulation training devices integrated into the medical treatment of casualties. . . . . (Recommended)
11. Flash/bang/smoke cues for nuclear events . . . . . (Recommended)
12. Traveling through a simulated contaminated area. . . . . (Recommended)
13. Nuclear training should be provided for unit size of:
    - Squad. . . . . (Recommended)
    - Platoon. . . . . (Recommended)
    - Company. . . . . (Recommended)
    - Battalion/task force . . . . . (Recommended)
    - Larger than battalion. . . . . .(Useful)
14. Nuclear simulation should provide for:
    - Total dose . . . . . (Recommended)
    - Dose rate. . . . . (Recommended)
    - Dose rate and total dose integrated together in training device . . . . . (Recommended)
    - Armor protection . . . . . (Recommended)
    - EMP/TREE simulation. . . . . (Recommended)

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

M. NUCLEAR/BIOLOGICAL/CHEMICAL. (Continued)

15. Simulation of biological toxins. . . . . (Recommended)
16. Simulation of biological organisms . . . . . (Recommended)
17. Simulation of contamination transfer:
    To interiors of armored vehicles . . . . . (Recommended)
    From one area to another by vehicles or personnel. . . . . (Recommended)
18. Provide surprise delivery to maneuver elements . . . . . (Recommended)
19. Provide surprise to Combat Support and Combat Service Support. (Recommended)
20. Persistent simulant decontamination similar to an actual agent (Recommended)
21. Simulation of non-persistent chemical agent. . . . . (Recommended)
22. Simulation of persistent chemical agent. . . . . (Recommended)
23. Delivery of chemical agents by aircraft. . . . . (Recommended)
24. Delivery of chemical agents by indirect fire . . . . . (Recommended)
25. Real-time casualty assessment when entering a contaminated area(Recommended)
26. Training in all MOPP levels. . . . . (Mandatory)

COMMENTS: It was proposed that nothing was more important on the modern battlefield. This would add a phase of training that is lacking in most field problems and could help identify many important problems. Furthermore, the N/B/C situation should be so realistic that it would force units to perform in accordance with the simulated situation. An opposing opinion was expressed by one person who gave all items an "Undesirable" rating because N/B/C simulation is too complicated.

The use of TES for N/B/C should be provided at 54E level and used by personnel in this area. Testing of units to survive in an N/B/C environment should be conducted by Chem Corp SMEs.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

N. MOUT. Please indicate, using the rating scale above, the importance to your organization of the TES simulation having the following capabilities in MOUT exercises:

1. Indication of simulated damage to buildings or other structures(Recommended)
2. Simulate the protection provided by urban buildings and structures. . . . . .(Recommended)
3. Simulate protection degradation from multiple hits on urban buildings and structures. . . . . .(Recommended)
4. Casualties on personnel inside buildings or other structures. .(Recommended)
5. Simulate TES weapons inside of buildings or other urban structures. . . . . .(Recommended)
6. Engage at night . . . . . .(Recommended)
7. Engage through obscurants . . . . . .(Recommended)
8. Engage at very close range. . . . . .(Recommended)
9. Simulate attrition from use of explosive charges. . . . . .(Recommended)
10. Emphasize the instrumentation of dismounted troops. . . . . .(Recommended)
11. Cues in MOUT:
    - Weapon firing . . . . . .(Recommended)
    - Noise . . . . . .(Recommended)
    - Flash . . . . . .(Recommended)
    - Smoke . . . . . .(Recommended)
    - Pellets, dye or colorant to mark hits . . . . . .(Recommended)
    - Hit signatures. . . . . .(Recommended)
    - Smoke from burning buildings. . . . . .(Recommended)

COMMENT: Simulated structural damage was rated mandatory by Special Forces and MPs. Another suggested that simulations for rubbling and artillery hits could easily be accomplished through controller play. One comment indicated the need to qualify the "obscurant" question with the need for realism in the capability.

Some NG and Reserve indicated a current lack of involvement in MOUT but considered it beneficial. Specific benefits of TES in MOUT were identified by other components. Benefits included: use by light infantry in preparation for guerillas; providing another environment for dismounted cavalry; and, allowing MOUT to be used with minimal OPFOR.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

0. COMMAND & CONTROL. Please indicate, using the rating scale above, the importance to your organization of including command and control elements in future exercises on the TES training battlefield:

1. Instrument command and control elements as targets . . . . . .(Recommended)
2. Simulate command and control functions which are one echelon higher than unit being trained . . . . . .(Recommended)
3. Instrument as targets command and control elements which are one echelon higher than unit being trained . . . . . (Useful)
4. Simulate tactical command and control systems such as TACFIRE.(Recommended)
5. Simulate or provide artillery FO, FDC, FAC, and ALO in TES exercise . . . . . .(Recommended)
6. Provide TES data or video of command and control of play for After Action Review. . . . . .(Recommended)
7. Provide TES communications data (who said what to whom, when) for After Action Review. . . . . .(Recommended)

COMMENTS: Command and Control play was noted as useful for training leaders at several levels (i.e., platoon, squad) and specifically highlighted as necessary for artillery and armor. This general expression of need was further qualified by a consideration that exercises of the magnitude that require this type of instrumentation will take place only at NTC, CMTC, and JRTC.

Even though advanced, complete AARs are needed, video and communication data were singled out as a items that may be cost prohibitive.

One Reserve unit indicated the need to concentrate more on successfully working as a task force with command and control rather than killing off those same elements.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

P. COMBAT SUPPORT. Please indicate, using the rating scale above, the importance to your organization of including combat support and combat service support elements in future exercises on the TES battlefield:

1. Instrument combat support vehicles only. . . . . (Recommended)
2. Instrument combat support personnel only . . . . . .(Useful)
3. Instrument all potential combat support targets. . . . . (Recommended)
4. Simulate combat support and combat service support elements. . . . .(Useful)
5. Provide logistics realism. . . . . (Recommended)
6. Provide for field medical diagnostic/treatment actions . . . . (Recommended)
7. Provide for problems of casualty evacuation. . . . . (Recommended)
8. Provide for problems of resupply . . . . . (Recommended)
9. Provide for problems of damage repair/retrieval. . . . . (Recommended)

COMMENT: All comments supported the need for combat support and combat service support on the TES battlefield. It was noted that there was little opportunity for these elements to provide support in a realistic combat environment except at a major training area and that they are presently unaccounted for in simulation.

The integration of these elements into training would enhance overall realism, aid in having a good and successful field problem, and give commanders a realistic picture of their unit's capability to do a mission. Armor was identified as one component where these elements are important; another respondent specified AP personnel and equipment forward of BSA/DSA. It was also suggested that CS equipment has the bigger influence and its operation should be controlled by exercise events.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

Q. COMMUNICATION DISRUPTION. Please indicate, using the rating scale above, the importance to your organization of including communication disruption in future exercises on the TES training battlefield:

1. Provide for the actual disruption of communications. . . . . (Recommended)
2. Provide for the simulated disruption of communications . . . . (Recommended)
3. Use actual RF jamming techniques . . . . . (Recommended)
4. Disrupt communications by non-RF methods using TES equipment . (Recommended)
5. Disrupt only selected channels . . . . . (Recommended)
6. Automatically attrit electronic equipment which is not protected. . . . . (Recommended)
7. Penalize excessive transmission time . . . . . (Recommended)
8. Simulate communication equipment damage. . . . . (Recommended)
9. Allow simulated repair of equipment/replacement. . . . . (Recommended)
10. Provide for antenna blowoff and field expedient replacement. . (Recommended)
11. Simulate electromagnetic interference on electronic sights . . (Recommended)
12. Simulate electromagnetic interference on computers or other electronic equipment. . . . . (Recommended)

COMMENTS: It was noted that communication plays a big role in achieving success and that units covering wide fronts are particularly vulnerable to associated problems. TES could provide training for preparedness for the loss of communication.

Actual disruption was noted as a possible problem in some areas, such as Europe, where airways are very restricted. Simulation may then be required if disruption is to enter into play. Two other specific considerations were pointed out in the comments: excessive transmission time is a major weakness in battalions making penalties "mandatory" and any system must provide for control override for emergencies.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

R. OPFOR. Please indicate, using the rating scale above, the importance to your organization of the following OPFOR characteristics which might be used on the training battlefield and which should be considered in the design of future TES:

( ) If you feel that TES for OPFOR is not necessary and that training should be force-on-force with both sides using U.S. equipment and tactics, please check this box and go to the next section.

1. Threat maneuver tactics and doctrine. . . . . .(Mandatory)
2. Actual OPFOR vehicles . . . . . .(Recommended)
3. VISMODs for OPFOR vehicles. . . . . .(Recommended)
4. Actual threat weapons . . . . . .(Recommended)
5. Threat weapon characteristics only . . . . . .(Recommended)
6. Threat weapon performance:
   Available (unclassified) capability . . . . . .(Recommended)
   Latest (classified) capability. . . . . .(Recommended)
7. Simulation of threat target vulnerability:
   Available (unclassified) capability . . . . . .(Recommended)
   Latest (classified) capability. . . . . .(Recommended)
8. Threat uniforms . . . . . .(Recommended)

COMMENTS: A current and precise OPFOR in weapons, tactics and doctrine was reinforced as a critical need. Realism and realistic OPFOR were frequently synonymous with successful training. Furthermore, it should be integrated and available at NTC and perhaps other major training centers. One comment indicated a desire to have OPFOR at specialized training areas and available to units for short FTXs at those sites.

A desire for the latest classified capability was expressed, but there were concerns for having classified materials in the field. It was suggested that having classified capabilities present could restrict training. TES should simulate actual numbers with unclassified general information.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

S. OBSCURATION. Please indicate, using the rating scale above, the importance to your organization of the following TES design considerations having to do with obscuration:

1. Shoot through obscurants. . . . . (Recommended)
2. Sight through obscurants. . . . . (Recommended)
3. Shoot through soft cover. . . . . (Recommended)
4. Provide IR-opaque training smoke. . . . . (Recommended)
5. Simulate only the effects of IR-opaque smoke. . . . . (Recommended)
6. Simulate delivery of obscurants by artillery. . . . . (Recommended)
7. Simulate delivery of obscurants by Chemical Corps units . . . (Recommended)

COMMENTS: Shooting and sighting through obscurants or soft cover should be limited to weapon/sight capabilities and what could reasonably be expected in the real world.

One comment suggested that Chemical Corps units would be a hindrance to unit training. There was no elaboration on this thought.

With thermal imagery, troops rely too much on their TTS. If multi-spectral smoke is simulated, troops will go back to working the degraded mode.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

T. SIGNATURES. Please indicate, using the rating scale above, the importance to your organization of the types of TES signatures which should be developed.

1. Signatures as cues for the firer. . . . . (Recommended)
2. Signatures as cues for the target . . . . . (Recommended)
3. Hit flash . . . . . (Recommended)
4. Kill smoke. . . . . (Recommended)
5. Weapon flash. . . . . (Recommended)
6. Weapon smoke. . . . . (Recommended)
7. Weapon bang . . . . . (Recommended)
8. Tracers . . . . . (Recommended)
9. Burst on target . . . . . (Recommended)
10. Incoming artillery or mortar flash. . . . . (Recommended)
11. Incoming artillery or mortar bang . . . . . (Recommended)
12. Incoming artillery or mortar smoke. . . . . (Recommended)
13. Mine flash . . . . . (Recommended)
14. Mine bang . . . . . (Recommended)
15. Mine smoke . . . . . (Recommended)
16. Different signatures for different weapons . . . . . (Recommended)
17. Different signatures for different ammunition . . . . . (Recommended)
18. Signatures through sight imaging systems. . . . . (Recommended)

COMMENTS: All players must have the potential to identify another player's firing or hit.

One respondent noted that tracers can only be effective with optical sights.

The flash, bang, and smoke from artillery and mortar could be hand-held by a controller.

In considering different signatures for different weapons, it was suggested that perhaps "generic signatures" were sufficient among weapons with no actual differences.

One question concerned signatures through sight imaging systems where a respondent rating would be an "0" (not a 1) depending on the type of training aid; specifically, the COFT and PGS systems were mentioned but the rating was not related to either system.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

U. ATTRITION. Please indicate, using the rating scale above, the importance to your organization of providing for the following attrition in future TES exercises:

1. Multiple levels of hits on vehicles, such as turret, hull, or tracks. . . . . (Recommended)
2. Higher probablility of kill for subsequent hits . . . . . (Recommended)
3. Hit quadrant on a vehicle, such as front, rear, or side . . . (Recommended)
4. The effect on the probability of kill of the impact angle of incoming rounds . . . . . (Recommended)
5. Multiple levels on individuals, such as torso, arm, leg . . . . . .(Useful)
6. Head shot on individuals (helmet detectors) . . . . . (Recommended)
7. Indication of who shot whom (for After Action Reviews). . . . (Recommended)
8. Distinguish/identify friendly kills (fratricide). . . . . (Recommended)

COMMENTS: Attrition was considered necessary because it forces staffs and support to respond to the battle. Multiple levels on individuals was noted as mandatory by some units with crew-served weapons. Identification of "who shot whom" for AAR was noted as important and mandatory but recognized as potentially unaffordable. Fratricide data is mandatory for AAR only.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Required. | (Don't buy a TES system without it.) |
| (2) | Highly Recommended. | (Training effectiveness degraded without it.) |
| (3) | Recommended. | (Worth spending money on.) |
| (4) | Useful. | (But not worth extra cost.) |
| (5) | Not Required. | |

V. CASUALTY ASSESSMENT. Please indicate, using the rating scale above, the importance to your organization of the following types of casualty assessment, in addition to the current near-miss, hit, and kill, that might be used in future TES exercises:

1. For vehicles, loss of mobility. . . . . (Recommended)
2. Loss of radio . . . . . (Recommended)
3. Attrition of individual crew members. . . . . (Recommended)
4. Casualties assessed automatically by the system, instead of using casualty cards. . . . . (Recommended)
5. Indication, for medics, of location, type, and severity of wounds. . . . . (Recommended)
6. Elimination of controller-assessed kills. . . . . .(Useful)

COMMENTS: Most comments expressed concern about a consideration to "eliminate" controller-assessed kills. Although the general desire for elimination or greater limitation was there, the need for a controller-assessed kill was established as providing flexibility for the incorporation of options into the play.

TES should be designed to provide additional information on casualty predictions.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

W. INTEROPERABILITY. Please indicate, using the rating scale above, the importance to your organization of the interoperability of future TES with other Army training systems:

1. MILES. . . . . (Mandatory)
2. UCOFT, or similar crew trainers. . . . . (Recommended)
3. TWGSS, or similar gunnery trainers . . . . . (Recommended)
4. ARTBASS, or other staff trainers . . . . . (Recommended)
5. Test instrumentation, such as used at CDEC, Ft. Hunter-Liggett, or TCATA, Ft. Hood . . . . . (Recommended)
6. Other NATO TES systems (such as or Talissi). . . . . (Recommended)
7. Future new equipment capabilities. . . . . (Recommended)
8. Future improvements to current tactical equipment. . . . . (Recommended)
9. Future threat equipment and capabilities . . . . . (Recommended)

COMMENT: Interoperability with MILES is necessary unless it is, and one noted it should be, replaced by a new TES. Additionally, TWGSS was suggested as being replaced by the new TES rather than designing interoperability.

One comment questioned how TES would interface with COFT and similar devices.

SIMNET capabilities should be added.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

X. CHEATING. Please indicate, using the rating scale above, the importance to your organization, in the design of future TES systems, of making it more difficult to cheat:

( ) If you feel that control of cheating is not important in the design of future TES systems, please check this box and go on to the next section.

1. Systems should be as cheat-proof as they can be made . . . . .(Recommended)
2. TES systems should display an indication when cheating has occurred . . . . . .(Recommended)
3. Use of MILES-type keys should be eliminated. . . . . .(Recommended)
4. Equipment should be made more tamper-proof . . . . . .(Recommended)
5. The number of soldier-operated controls should be minimized .(Recommended)
6. More functions should be delegated to controllers . . . . . (Useful)

COMMENT: Cheating will always be present to some degree but efforts should be made to minimize it within some cost limits. The control of cheating was seen as a chain of command function and/or a hardware problem. Hardware suggestions included incorporating a changeable electronic key and redesigning the present key.

The controller's function should be in tactical operations and should not include TES administrative functions.

IF a new TES system could eliminate controllers, each individual acting as a controller could be participating as a player. Trainers would be responsible for extracting data from TES for AAR purposes.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

Y. CONTROLLERS. Please indicate, using the rating scale above, the importance to your organization of the role of controllers in future TES force-on-force exercises:

1. Control the flow of the exercise to meet training objectives . (Recommended)
2. Arbitrate problems and disputes as referees . . . . . (Recommended)
3. Evaluate trainees. . . . . (Recommended)
4. Assess casualties. . . . . .(Useful)
5. Prevent cheating . . . . . (Recommended)
6. Emphasis should be placed on using TES to decrease the number of controllers . . . . . (Recommended)
7. More use should be made of controllers from other than military combat units . . . . . .(Useful)
8. TES systems should be designed to reduce the workload on controllers. . . . . (Recommended)

COMMENT: The flow of training operations should be dependent on the abilities of the participants to act and should not be a function of controllers.

If TES could be made to do everything desired, the controllers would not need to settle disputes.

Evaluation of trainees, casualty assessment, and cheating prevention were seen as functions to be conducted by trainer/evaluator. It was stated that unit command is the evaluator, is the POC for preventing cheating, and controls the flow to meet training objectives. Another considered evaluation to be a co-workload with the player's chain of command. Also, if cheating is made impossible or improbable, controllers would not have to prevent it.

To reduce the numbers of controller, some respondents set specifications, such as: controllers should be at platoon level with perhaps two at that level; the sy ) should be designed to require only one controller; and, the number of controllers may need adjustment depending on the exercise.

Controllers should be at the level or position of those being tested.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

Z. POSITION LOCATION. Please indicate, using the rating scale above, the importance to your organization of having player position location for exercise control and After Action Reviews:

1. Location of every player . . . . . .(Useful)
2. Location of major weapons only (tanks, TOW, etc.) . . . . . (Recommended)
3. Location of all but dismounted individual troops . . . . . .(Useful)
4. Location to within 100 meters . . . . . .(Useful)
5. Location to within 10 meters . . . . . .(Useful)
6. Location to within 1 meter . . . . . .(Useful)
7. Include altitude as well as X,Y coordinates . . . . . .(Useful)
8. Include orientation of vehicle . . . . . .(Useful)
9. Include orientation of weapon . . . . . .(Useful)
10. Location continuously updated . . . . . .(Useful)
11. Location needed only when engaging (or being engaged) . . . . (Recommended)

COMMENT: One comment concerning position location data for AAR suggested that the information should not be available to players unless the information is available in combat (i.e., intelligence). The data could be displayed at control centers which could be useful for AAR development of doctrine and tactics.

Comments supported position location data on key leaders, major players, platoon location, and major systems (within 100 meters) instead of every player. In fact, ADA considered it critical.

One comment warned that too much information seems to swamp the processing circuits of most people.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

AA. INTERVISIBILITY.* Please indicate, using the rating scale above, the importance to your organization of including intervisibility instrumentation in future training exercises:

( ) If you feel that intervisibility will not be important in future training exercises, please check this box and go on to the next section.

1. Include intervisibility in all levels of training . . . . . .(Recommended)
2. Provide intervisibility instrumentation only for major weapons systems . . . . . .(Recommended)
3. Provide intervisibility as an option only for gunnery training.(Recommended)

COMMENTS: Comments ranged from "very important to armor" to "this question needs rewording". A general message indicated a possible misunderstanding of this question.

* Intervisibility has to do with target acquisition. A target is intervisible to a weapon when it is capable of being acquired by that weapon, whether or not it actually is. It follows that the weapon at that time is also intervisible to the target. In gunnery, related factors are: how many targets were intervisible, when they became intervisible, when they were acquired, when they were identified, and when they were fired upon.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

BB. DATA COLLECTION. Please indicate, using the rating scale above, the importance to your organization of providing increased capability for the collection of engagement data during future exercises on the TES training battlefield:

1. Simplify field equipment by minimizing automatic data collection . .(Useful)
2. Provide for on-board storage of at least some engagement data (for retrieval after the exercise) . . . . . (Recommended)
3. Provide for real-time display or transmission of at least some engagement data . . . . . (Recommended)
4. Provide video taping of overall maneuver areas . . . . . (Recommended)
5. Provide video taping of sight pictures . . . . . .(Useful)
6. Provide computer graphics for After Action Reviews . . . . . (Recommended)
7. Include player position location in TES instrumentation. . . . (Recommended)
8. Include firing weapon ID in the data sent to the target. . . . (Recommended)

COMMENT: Comments supported collection and on-board storage of all data for AAR but qualified this by a desire not to burden units with data collection and the importance of considering the differences between instrumentation needs at home stations versus NTC, CMT, or JRTC. For example, video taping, computer graphics, and position location may be limited to NTC.

Firing weapon ID should be by weapon type, not by the specific weapon owner, and position location data should not include individual dismounted players.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

CC. SIZE. Please indicate, using the rating scale above, the importance to your organization of equipment size in the design of future TES systems:

1. Future TES should be smaller than MILES. . . . . .(Recommended)
2. Size is more important than increased capability . . . . . (Useful)
3. Reduce size to improve transparency to the user. . . . . .(Recommended)
4. Eliminate helmet detectors and associated electronics. . . . . (Useful)

COMMENTS: Smaller size, especially for the individual, was the general comment but rated as more important was improved reliability and capability.

Concerns about helmets were expressed. Some do not normally wear helmets in the field or wear them only during the day, resulting in a desire to eliminate helmet detectors. One specifically stated the desire to eliminate helmet detectors but also emphasized that the determination of head hits was still desired. A system which has the hardware built into the helmet and LCE was also suggested as being superior to the current system.

Because of the current size and positon of MWLDs and rifle transmitters, SF, Rangers, and Airborne units must go to an administrative status to put on MILES after a tactical jump. This condition was identified as detrimental to realistic training.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

DD. WEIGHT. Please indicate, using the rating scale above, the importance to your organization of weight in the design of future TES systems.

1. The maximum weight for TES equipment carried by infantry must be:
   Less than 2 pounds . . . . . .(Recommended)
   Less than 10 pounds . . . . . .(Recommended)
   Less than 20 pounds . . . . . (Not Useful)
2. The maximum weight for TES equipment on a helicopter must be:
   Less than 50 pounds . . . . . .(Recommended)
   Less than 200 pounds . . . . . (Useful)
3. The maximum weight for TES equipment on a fixed-wing aircraft must be:
   Less than 50 pounds . . . . . .(Recommended)
   Less than 200 pounds . . . . . (Useful)

COMMENTS: Lighter weight was noted as being better, but one comment stated "proper combat load" to be appropriate for infantry.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

EE. TYPE OF ELECTRICAL POWER. Please indicate, using the rating scale above, the importance to your organization of the source of electrical power for future TES systems:

1. Use vehicle power whenever possible . . . . . (Recommended)
2. Use special high performance batteries . . . . . (Useful)
3. Use standard commercial batteries. . . . . .(Useful)
4. Use rechargeable batteries . . . . . (Recommended)
5. Minimize use of batteries. . . . . (Recommended)
6. Use size and quantity of batteries to provide longer power duration than MILES. . . . . (Recommended)

COMMENTS: Proposed sources for electrical power for TES on vehicles were: from the vehicle; from a solar power and battery device; from batteries; or, from high performance, rechargeable batteries. Advantages stated for the use of vehicular power included the reduction in many CSS and controller functions. A disadvantage of the vehicular power proposal would be the undesirable result of the ineffectiveness of TES equipment if there was a vehicle power problem or shut down.

The use of commercial batteries was suggested to be too expensive but desirable from a logistics point of view. In considering rechargeable batteries, the man-hour intensive job of recharging must be remembered and consideration given to the use of mass chargers or by contracting recharging. The placement of required batteries in the ammo pouch was suggested.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

FF. BUILT-IN TEST (BITE). Please indicate, using the rating scale above, the importance to your organization of the types of Built-In Test Equipment (BITE) that should be included as part of future TES systems:

( ) If you feel that BITE is not important in future TES systems, please check this box and go on to the next section.

1. BITE operable by user . . . . . (Recommended)
2. BITE operable by repair personnel only . . . . . (Recommended)
3. Activates automatically . . . . . (Recommended)
4. System-level BITE (Go/No Go only) . . . . . (Recommended)
5. System-level BITE (which component is bad) . . . . . (Recommended)
6. Component-level BITE (what's wrong) . . . . . (Recommended)

COMMENTS: BITE was considered desirable and a potential improvement in equipment effectiveness but there was no consensus of opinion expressed as to who should use BITE. The appropriate user of a BITE system was considered to be from the level of user to repair personnel. Some stated that the operator should be responsible for the operation of his own equpment and, with BITE, could more effectively replace bad components within the unit, with subsequent component repair at a higher echelon. Shorter downtime was seen as a product of BITE particularly when training time is short.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

GG. INSTALLATION. Please indicate, using the rating scale above, the importance to your organization of the following, relating to the installation of future TES equipment:

1. More permanent installation . . . . . (Useful)
2. Much easier to install than MILES . . . . . .(Recommended)
3. Installation at a TES installation facility . . . . . (Not Useful)
4. Installation anywhere in the field. . . . . .(Recommended)
5. Installation by civilian personnel. . . . . (Not Useful)
6. Installation by military personnel. . . . . .(Recommended)
7. Installation by specialists . . . . . (Not Useful)

COMMENT: A more permanent installation was noted as beneficial with respect to time and money. The time it takes for installation, as well as other administrative functions such as issue, may be inversely proportional to the use of current devices.

Limited component changeout is a possibility: however, any installation required should be completed by the crew/user without requiring extra support from specialists, civilians, etc. Cost and the ability to keep training continously going were reasons cited for this common position.

One comment, indicating a desire for a "platform that can go to war without removing a ton of TES", was directed toward a more permanent installation (to reduce cost) but could be considered in the context of combat readiness.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

HH. ISSUE. Please indicate, using the rating scale above, the importance to your organization of the following in the warehousing and issue of future TES equipment:

1. At least some components of future TES systems should be kept by each soldier . . . . . .(Not Useful)
2. Future TES should be resident in the battalion . . . . . (Recommended)
3. Future TES should be issued from TASC as it is now . . . . . .(Useful)
4. TES equipment issued should be boxed for two-man carry . . . . (Recommended)
5. Emphasis should be placed on expendable TES equipment or devices . .(Useful)
6. TES equipment set should include test and checkout equipment . (Recommended)
7. Each battalion should have enough TES equipment for a platoon size unit for local area training. . . . . (Recommended)

COMMENT: Having TES resident in the battalion (item 2) and the amount of each equipment for each battalion for local area training (item 7) received numerous comments. In considering residency: usage may increase with more availability, cost is a factor, and storage must be considered. One comment noted that the current emphasis is to issue at the installation level according to ability to use. Another comment indicated the USAREUR has a community-based (not unit-based) distribution system.

The comments indicated that some respondents rated item 7 as "undesirable" because the implied quantity was not high enough while others rated it as "mandatory" with the qualifier that the quantity should be higher. The opinions indicated a desire for issue for two companies (permitting force-on-force, company-level), company size (to conduct platoon ARTEPs and to allow a bridage to consolidate equipment for a battalion ARTEP), at least two platoons, and one complete battalion per brigade.

There was some concern about time and delays in drawing TES from TASC: consideration of TASC providing coordinated issue without burdening the unit with additional costs/equipment must be given. One stated that the current consolidated method works well and TASC does facilitate multiple use. Local supply and field DX were seen as positive in maximizing training time.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

II. MAINTENANCE. Please indicate, using the rating scale above, the importance to your organization of the following in the maintenance of future TES equipment:

1. TES components designed for maximum serviceability in the unit.(Recommended)
2. TES systems designed for easy fault isolation to the component level:
   - By troops . . . . . .(Recommended)
   - By TASC . . . . . .(Recommended)
   - By CLS only . . . . . (Useful)
3. Component replacement in the field. . . . . .(Recommended)
4. Component replacement by TASC . . . . . .(Recommended)
5. Component repair by TASC. . . . . .(Recommended)
6. Repair by military personnel. . . . . .(Recommended)
7. Repair by civilian personnel. . . . . .(Recommended)

COMMENTS: There were some comments supporting TASC repair and replacement of parts, as well as some contrary opinions. One suggested no servicing by the unit and recommended civilian repair thereby avoiding perceived problems in government supply channels. At the other extreme was a suggestion to have maintenance so simplified that a soldier could keep the equipment in operation.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

JJ. TES EQUIPMENT TRAINING. Please indicate, using the rating scale above, the importance to your organization of providing for the following training in the use of future TES:

1. Introduction to TES as part of basic training . . . . . (Recommended)
2. Expand TES training to include the limitations inherent in simulation . . . . . (Recommended)
3. Expand TES training to include maintenance and fault isolation of some TES equipment. . . . . .(Useful)
4. Provide more training aids for the installation of TES . . . . . .(Useful)
5. Provide more training aids for maintenance of TES and fault isolation for TES components . . . . . .(Useful)
6. Provide videotapes for TES training. . . . . (Recommended)
7. Provide simulators of TES equipment for classroom/dayroom training .(Useful)
8. Provide training aids for controllers. . . . . (Recommended)

COMMENT: Differing comments on TES training ranged from the opinion that trainees have better things to do with their time at OUST or AIT and that training is a unit responsibility, to suggesting that the POI needs to be changed to allow time for such training. Basic training should be limited to introduction of equipment while further TES training is more important to the decision makers.

One respondent, in commenting specifically about vehicles, suggested that TES should be considered part of the vehicle and training should occur with normal vehicular training. Information on how to use vehicular TES capability should also be embedded.

Some comments specifically restated that any implied simulator (???) of a simulator was not desirable.

PNS QUESTIONNAIRE

TES NEEDS RATING SCALE

| | | |
|---|---|---|
| (1) | Mandatory. | (Don't buy a TES system without it) |
| (2) | Recommended. | (Training effectiveness would be degraded without it) |
| (3) | Useful. | (But not worth adding to system cost) |
| (4) | Not Useful. | (Has little or no training benefit) |
| (5) | Undesirable. | (Don't want; may result in negative training) |
| (0) | Not Rated. | (Cannot assign a priority to this item as I am not qualified, not interested, don't know, etc.) |

KK. TARGETS. Please indicate, using the priority rating scale above, the importance to your organization of having TES instrumentation for live fire targets as follows:

1. Cues to indicate hit or near miss or kill. . . . . (Recommended)
2. Hit sensors on targets . . . . . (Recommended)
3. Targets with capability for simulated shootback. . . . . (Recommended)
4. Real-time casualty assessment for near miss, hit, or kill of targets. . . . . (Recommended)
5. Probability of kill adjusted for number of hits on target. . . (Recommended)
6. Weapon and target pairing data for when a target is observed . (Recommended)
7. Weapon and target pairing data for when a weapon is fired. . . (Recommended)
8. Weapon and target pairing data for when a hit is accomplished. (Recommended)

COMMENTS: "Nothing can replace live fire except practice on weapons we don't shoot." Wind, recoil, noise, ballistics, etc., must all duplicate the real weapon. A close marriage between TES and live fire was seen as proper for good training: however, the extreme opinion that TES was not appropriate for live fire was also expressed.

With respect to probability of kill adjustments, one respondent stated a need for sensors to be located outside of the ballistic path. Another, responding to sensors in general, indicated that hit sensors are unreliable, can provide wrong data, and should be eliminated by using technology that provides a more accurate hit determination.

APPENDIX B

SECTION 3

TABULATED PNS RESPONSES

Centers and Schools ..... B-48
Active Combat Units ..... B-58
Reserve Units and National Guard ..... B-68

TES PNS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

RESULTS OF PNS QUESTIONNAIRE FOR TES
06-Nov-87
RESULTS OF THE SCHOOLS ONLY

A = 0.50 TO 1.50
B = 1.51 TO 2.50
C = 2.51 TO 3.51
D = 3.51 TO 4.51
E = 4.51 TO 5.0

| | PP | CATA | ADACENT | BAVIATION | USAFACFS | ENGINEER | INFANTRY | ARMOR | AVERAGE | STAND DEV | NO. REPLIES | GRADE DISTRIBUTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVER. | | AVER. | TSC,DPTM | AVER. | AVER. | AVER. | | | | | 1 | 2 | 3 | 4 | 5 | |
| | 1-3,35,3 | 4 | 6-12 | 13 | 14-18 | 19-22,1224-34,37 | | | | | | | | | | | |
| A. TYPE OF TRAINING | | | | | | | | | | | | | | | | | |
| A1. Maneuver | 1.1 | 2 | 1.4 | 1 | 1.2 | 1.5 | 1.1 | | 1.3 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| A2. Gunnery | 1.3 | 2 | 1.8 | 2 | 1.8 | 2.0 | 1.1 | | 1.7 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| A3. Command/leader | 2.3 | 2 | 2.5 | 2 | 1.6 | 1.6 | 1.9 | | 2.0 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| A4. Command and Control S | 2.4 | 2 | 2.7 | 2 | 2.2 | 1.8 | 2.2 | | 2.2 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| A5. Crew Skills | 1.4 | 1 | 1.1 | 2 | 1.8 | 2.3 | 1.7 | | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| A6. Technical Skills | 1.9 | 2 | 2.1 | 2 | 1.8 | 2.3 | 2.4 | | 2.1 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | * |
| A7. Combat Support | 2.0 | 2 | 2.5 | 3 | 1.6 | 2.0 | 2.3 | | 2.2 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| A8. Combat service suppor | 2.5 | 2 | 2.7 | 3 | 2.0 | 2.4 | 2.5 | | 2.4 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| A9. Multi-Echelon | 2.3 | 1 | 2.7 | 3 | 1.6 | 2.2 | 2.2 | | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| A10. With Foreign Units | 3.0 | 1 | 3.3 | 3 | 2.8 | 3.0 | 2.7 | | 2.7 | 0.7 | 7 | 1 | 0 | 6 | 0 | 0 | |
| A11. MOUT | 1.9 | 2 | 2.6 | 3 | 2.0 | 1.8 | 2.5 | | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| A11. Other | | | | | | | | | | | | | | | | | |
| B. LOCATION OF TRAINING | | | | | | | | | | | | | | | | | |
| B1. Theater | 3.1 | 1 | 2.0 | 2 | 2.0 | 2.8 | 2.6 | | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| B2. Major training center | 1.6 | 1 | 1.1 | 1 | 1.2 | 1.2 | 1.4 | | 1.2 | 0.2 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| B3. Smaller training cent | 1.6 | 1 | 1.9 | 1 | 1.2 | 1.2 | 1.6 | | 1.3 | 0.3 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| B4. Dedicated training ce | 2.0 | 1 | 1.8 | 2 | 1.8 | 2.0 | 1.9 | | 1.8 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| B5. Large home stations | 1.4 | 1 | 1.3 | 2 | 1.4 | 1.8 | 1.3 | | 1.4 | 0.3 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| B6. Smaller home stations | 1.4 | 1 | 1.9 | 3 | 1.4 | 1.8 | 1.3 | | 1.7 | 0.6 | 7 | 4 | 2 | 1 | 0 | 0 | ** |
| B7. Schools | 2.4 | 2 | 2.2 | 3 | 1.8 | 2.0 | 1.3 | | 2.1 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| B8. National Guard Armory | 1.9 | 1 | 2.8 | 3 | 2.3 | 2.3 | 2.2 | | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| B9. Army reserve Training | 1.6 | 1 | 3.0 | | 2.5 | 2.8 | 1.7 | | 2.1 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| C. UNIT SIZE | | | | | | | | | | | 0 | | | | | | |
| C1. Individual | 1.4 | 2 | 2.3 | 2 | 1.6 | 2.5 | 2.0 | | 2.0 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| C2. Crew/team | 1.3 | 2 | 2.4 | 2 | 1.4 | 1.8 | 1.2 | | 1.7 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| C3. Squad/Section | 1.3 | 2 | 2.0 | 2 | 1.4 | 1.7 | 1.2 | | 1.6 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| C4. Platoon/Troop | 1.6 | 2 | 2.3 | 2 | 1.2 | 1.3 | 1.1 | | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| C5. Company | 1.6 | 2 | 1.9 | 2 | 1.2 | 1.0 | 1.1 | | 1.5 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| C6. Battalion | 2.1 | 2 | 1.9 | 1 | 1.4 | 1.2 | 1.5 | | 1.6 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| C7. Battalion Task Force | 2.1 | 2 | 2.0 | 2 | 1.4 | 1.0 | 1.5 | | 1.7 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| C8. Regiment/Brigade | 3.0 | 2 | 2.2 | 2 | 1.8 | 2.4 | 2.6 | | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| C9. Division | 3.1 | 2 | 2.8 | 3 | 2.2 | 3.0 | 3.4 | | 2.8 | 0.5 | 7 | 0 | 2 | 5 | 0 | 0 | |
| C10.Corps/Echelons above | 3.9 | 2 | 3.3 | 3 | 3.0 | 3.3 | 3.6 | | 3.2 | 0.6 | 7 | 0 | 1 | 4 | 2 | 0 | xxx |
| D. TYPE OF INSTRUMENTED PLATFORM | | | | | | | | | | | | | | | | | |
| D1. Dismounted troops | 1.3 | 1 | 1.5 | 2 | 1.0 | 1.0 | 1.5 | | 1.3 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| D2. Crew-served ground we | 1.3 | 1 | 1.2 | 2 | 1.0 | 1.2 | 1.3 | | 1.3 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| D3. Armored vehicle | 1.3 | 1 | 1.0 | 2 | 1.0 | 1.2 | 1.0 | | 1.2 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| D4. Non-armored vehicles | 2.6 | 1 | 2.0 | 2 | 1.4 | 2.5 | 1.5 | | 1.9 | 0.5 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| D5. Air defense artillery | 1.3 | 1 | 1.5 | 2 | 1.6 | 1.5 | 1.7 | | 1.5 | 0.3 | 7 | 4 | 3 | 0 | 0 | 0 | ** |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

TES PNS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D6. Self-propelled howitz | 1.4 | 1 | 2.3 | 2 | 1.6 | 1.7 | 1.6 | 1.7 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| D7. Towed howitzers | 1.6 | 1 | 2.5 | 2 | 2.2 | 2.0 | 1.9 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| D8. Attack helicopters | 1.3 | 1 | 1.1 | 2 | 1.6 | 1.7 | 1.2 | 1.4 | 0.3 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| D9. Scout helicopters | 1.3 | 1 | 1.1 | 2 | 1.8 | 2.0 | 1.3 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| D10. Transport helicopter | 1.9 | 1 | 1.7 | 2 | 2.4 | 3.0 | 2.0 | 2.0 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| D11. Surveillance aircraf | 1.9 | 1 | 2.3 | 2 | 2.4 | 2.4 | 2.3 | 2.0 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 | * |
| D12. Low speed aircraft | 1.7 | 1 | 1.2 | 2 | 2.4 | 2.2 | 2.2 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| D13. High speed aircraft | 1.7 | 1 | 1.3 | 2 | 2.0 | 2.5 | 1.7 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| D14. Combat service suppo | 2.1 | 1 | 3.3 | 2 | 2.0 | 2.3 | 2.1 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| D15. All platforms/vehicl | 3.0 | 1 | 2.7 | 2 | 2.0 | 2.7 | 2.3 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| E. TYPE OF WEAPONS | | | | | | | | | | | | | | | | |
| E1. Pistol | 4.3 | 2 | 3.5 | 3 | 2.6 | 3.8 | 3.4 | 3.2 | 0.7 | 7 | 0 | 1 | 4 | 2 | 0 | xxx |
| E2. Rifle | 1.4 | 2 | 2.3 | 2 | 1.2 | 1.2 | 1.7 | 1.7 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| E3. Machine gun | 1.4 | 2 | 1.5 | 2 | 1.2 | 1.3 | 1.4 | 1.6 | 0.3 | 7 | 5 | 2 | 0 | 0 | 0 | ** |
| E4. Hand grenade | 3.1 | 2 | 3.0 | 3 | 1.6 | 3.0 | 3.2 | 2.7 | 0.6 | 7 | 0 | 2 | 5 | 0 | 0 | |
| E5. Grenade launcher | 2.0 | 2 | 2.8 | 2 | 1.6 | 2.5 | 2.6 | 2.2 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| E6. Explosive charges | 2.9 | 2 | 3.0 | 3 | 1.4 | 2.8 | 2.9 | 2.6 | 0.6 | 7 | 1 | 1 | 5 | 0 | 0 | |
| E7. Mines, conventional | 2.1 | 2 | 3.0 | 3 | 1.2 | 2.3 | 1.8 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| E8. Mines, scatterable | 2.3 | 2 | 2.8 | 3 | 1.2 | 2.3 | 1.8 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| E9. Mines Chemical | 2.6 | 2 | 3.0 | 3 | 1.2 | 3.0 | 2.2 | 2.4 | 0.6 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| E10. Mortar | 2.3 | 1 | 2.8 | 3 | 1.8 | 2.0 | 2.0 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| E11. Tank/fighting vehicl | 1.3 | 1 | 1.5 | 3 | 1.2 | 1.3 | 1.0 | 1.5 | 0.6 | 7 | 6 | 0 | 1 | 0 | 0 | *** |
| E12. Air defense | 1.6 | 2 | 1.0 | 3 | 1.8 | 1.5 | 1.7 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| E13. Antitank guided miss | 1.4 | 2 | 1.0 | 3 | 1.2 | 1.3 | 1.2 | 1.6 | 0.6 | 7 | 5 | 1 | 1 | 0 | 0 | ** |
| E14. Artillery, conventio | 1.6 | 1 | 2.2 | 1 | 1.8 | 1.5 | 1.5 | 1.5 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| E15. Artillery, rocket | 2.3 | 1 | 2.5 | 1 | 2.0 | 1.8 | 1.7 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| E16. Artillery, chemical | 2.1 | 1 | 2.8 | 1 | 2.0 | 1.8 | 1.9 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| E17. Aircraft bombs/clust | 2.4 | 1 | 2.6 | 3 | 1.8 | 2.3 | 1.8 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| E18. Air-to-air | 2.3 | 1 | 1.3 | 3 | 2.6 | 3.3 | 2.2 | 2.2 | 0.8 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| E19. Air-to-surface | 2.1 | 1 | 1.0 | 3 | 2.4 | 3.0 | 1.7 | 2.0 | 0.8 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| E20. Directed energy | 2.8 | 1 | 2.0 | 3 | 2.0 | 3.0 | 1.8 | 2.2 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| F. SMART WEAPONS | | | | | | | | | | | | | | | | |
| F1. Weapon assembly and s | 3.0 | | 2.3 | 3 | 2.8 | 3.4 | 2.8 | 2.9 | 0.3 | 6 | 0 | 1 | 5 | 0 | 0 | |
| F2. Weapon checkout | 3.0 | | 2.0 | 3 | 2.8 | 3.0 | 2.8 | 2.8 | 0.4 | 6 | 0 | 1 | 5 | 0 | 0 | |
| F3. Loading | 2.8 | | 2.0 | 3 | 2.5 | 3.3 | 2.4 | 2.7 | 0.4 | 6 | 0 | 3 | 3 | 0 | 0 | |
| F4. Target acquisition | 1.8 | | 1.1 | 2 | 1.8 | 1.8 | 1.9 | 1.7 | 0.3 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| F5. Aiming and tracking | 1.5 | | 1.1 | 2 | 1.5 | 1.6 | 1.9 | 1.6 | 0.3 | 6 | 3 | 3 | 0 | 0 | 0 | ** |
| F6. Firing | 1.5 | 1 | 1.0 | 2 | 1.3 | 1.8 | 1.8 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| F7. Weapon firing signatu | 2.3 | 1 | 1.4 | 2 | 2.0 | 2.2 | 1.9 | 1.8 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| F8. Target area effects | 2.5 | 1 | 2.3 | 1 | 1.3 | 2.5 | 1.8 | 1.8 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| F9. Realtime casualty ass | 2.2 | 1 | 1.1 | 1 | 1.0 | 2.5 | 1.7 | 1.5 | 0.6 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| F10. Integration of all o | 2.5 | 1 | 1.6 | 2 | 2.3 | 2.6 | 2.1 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| G. SIMULATED GUNNERY | | | | | | | | | | | | | | | | |
| G1. Shoot-on-the-move | 1.4 | 1 | 1.3 | 3 | 1.5 | 1.5 | 1.1 | 1.5 | 0.6 | 7 | 6 | 0 | 1 | 0 | 0 | ** |
| G2. Shoot at moving targe | 1.4 | 2 | 1.3 | 2 | 1.5 | 1.5 | 1.1 | 1.5 | 0.3 | 7 | 5 | 2 | 0 | 0 | 0 | ** |
| G3. Target lead | 1.7 | 1 | 1.6 | 3 | 1.5 | 2.0 | 1.2 | 1.7 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| G4. Wind effects, ballist | 2.4 | 1 | 2.1 | 3 | 1.5 | 2.0 | 1.9 | 2.0 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| G5. Selection of ammuniti | 2.6 | 1 | 2.2 | 3 | 1.5 | 2.2 | 1.3 | 2.0 | 0.7 | 7 | 3 | 2 | 2 | 0 | 0 | ** |
| G6. Ranging | 1.7 | 1 | 1.4 | 3 | 1.5 | 2.0 | 1.3 | 1.7 | 0.6 | 7 | 4 | 2 | 1 | 0 | 0 | ** |
| G7. Ballistics | 2.0 | 1 | 2.1 | 3 | 1.8 | 1.8 | 1.2 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| G8. Simulation of weapon | 1.6 | 1 | 1.9 | 2 | 1.3 | 1.7 | 1.5 | 1.5 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | ** |

RESULTS OF OMS QUESTIONNAIRE FOR ARMY SCHOOLS

TES PNS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G9. Provide for the effec | 2.1 | 1 | 1.5 | 3 | 1.2 | 2.2 | 1.5 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| G10. Burst-on-target-cue | 2.6 | 1 | 2.3 | 2 | 2.0 | 2.0 | 1.4 | 1.9 | 0.5 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| G11. Tracers | 2.6 | 1 | 3.1 | 4 | 2.8 | 1.8 | 1.7 | 2.4 | 0.9 | 7 | 1 | 2 | 3 | 1 | 0 | * |
| G12. Firing cues and sign | 2.4 | 1 | 2.0 | 4 | 2.0 | 2.2 | 1.5 | 2.2 | 0.9 | 7 | 1 | 5 | 0 | 1 | 0 | * |
| G13. TES to supplement li | 1.7 | 1 | 2.0 | 3 | 2.0 | 2.8 | 1.8 | 2.0 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| G14. TES to replace live | 3.1 | 2 | 3.9 | 4 | 2.3 | 4.6 | 4.0 | 3.4 | 0.9 | 7 | 0 | 2 | 1 | 3 | 1 | xxx |
| G15. Provide same system | 2.6 | 1 | 1.4 | 4 | 2.0 | 1.8 | 1.8 | 2.1 | 0.9 | 7 | 2 | 3 | 1 | 1 | 0 | * |
| G16. Simulation of recoil | 2.4 | 1 | 2.9 | 4 | 2.0 | 2.2 | 2.5 | 2.4 | 0.8 | 7 | 1 | 4 | 1 | 1 | 0 | * |
| G17. Simulation of loadin | 2.6 | 1 | 2.4 | 4 | 2.0 | 2.5 | 1.8 | 2.3 | 0.8 | 7 | 1 | 4 | 1 | 1 | 0 | * |
| G18. Zero or boresight of | 1.7 | 2 | 2.1 | 4 | 2.0 | 2.0 | 1.7 | 2.2 | 0.7 | 7 | 0 | 6 | 0 | 1 | 0 | * |
| G19. Dry-firing of weapon | 2.7 | 2 | 2.4 | 4 | 2.5 | 2.2 | 2.4 | 2.6 | 0.6 | 7 | 0 | 5 | 1 | 1 | 0 | |
| G20. Real-time feedback t | 2.0 | 2 | 1.4 | 4 | 1.8 | 1.5 | 1.5 | 2.0 | 0.8 | 7 | 3 | 3 | 0 | 1 | 0 | * |
| H. EMBEDDING | | | | | | | | | | | | | | | | |
| H0. Embedding is not desi | 2.0 | | 1.0 | | 1.0 | 1.0 | 1.0 | 1.2 | 0.4 | 5 | 4 | 1 | 0 | 0 | 0 | *** |
| H1. Small arms | 3.3 | 1 | | 4 | 1.0 | 4.0 | 3.5 | 2.8 | 1.3 | 6 | 2 | 0 | 2 | 2 | 0 | |
| H2. Crew-served weapons | 2.7 | 1 | 3.0 | 4 | 1.0 | 3.5 | 2.8 | 2.6 | 1.1 | 7 | 2 | 0 | 4 | 1 | 0 | |
| H3. Armored vehicles | 2.5 | 1 | 2.0 | 4 | | 3.5 | 1.5 | 2.4 | 1.1 | 6 | 1 | 3 | 1 | 1 | 0 | * |
| H4. Non-armored vehicles | 3.2 | 1 | 3.0 | 4 | 1.0 | 3.0 | 2.6 | 2.5 | 1.0 | 7 | 2 | 0 | 4 | 1 | 0 | |
| H5. Artillery | 2.6 | 1 | 2.0 | 4 | 2.0 | 3.5 | 2.0 | 2.4 | 0.9 | 7 | 1 | 3 | 2 | 1 | 0 | * |
| H6. Helicopters | 2.2 | 1 | 1.8 | 4 | 3.0 | 3.5 | 1.8 | 2.5 | 1.0 | 7 | 1 | 3 | 2 | 1 | 0 | * |
| H7. Aircraft | 2.2 | 1 | 1.7 | 4 | 2.0 | 3.5 | 2.0 | 2.3 | 1.0 | 7 | 1 | 4 | 1 | 1 | 0 | * |
| H8. Provide engagement re | 2.0 | 1 | 2.0 | 5 | 2.0 | 3.5 | 2.1 | 2.5 | 1.2 | 7 | 1 | 4 | 1 | 0 | 1 | |
| I. AIR DEFENSE | | | | | | | | | | | | | | | | |
| I1. Provide TES which rea | 1.8 | 1 | 1.1 | 3 | 2.0 | 1.8 | 1.9 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| I2. Provide instrumented | 3.2 | 1 | 2.8 | 3 | 3.3 | 2.8 | 2.8 | 2.7 | 0.7 | 7 | 1 | 0 | 6 | 0 | 0 | |
| I3. Instrument helicopter | 1.6 | 1 | 1.3 | 3 | 2.3 | 2.8 | 2.0 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | ** |
| I4. Instrument low speed | 1.8 | 1 | 1.5 | 3 | 2.3 | 2.8 | 2.1 | 2.1 | 0.6 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| I5. Instrument fast mover | 2.2 | 1 | 2.0 | 3 | 2.5 | 2.3 | 2.3 | 2.2 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| I6. Realistically simulat | 2.0 | 1 | 1.1 | 3 | 2.5 | 2.3 | 2.0 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| I7. Include capability to | 1.8 | 1 | 1.8 | 2 | 1.8 | 2.0 | 2.6 | 1.8 | 0.4 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| I8. Include IFF in all en | 1.8 | 1 | 1.0 | 3 | 2.8 | 2.4 | 2.4 | 2.1 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| I9. In maneuver exercise, a/d should be simulated out to a range of: | | | | | | | | | | | | | | | | |
| I9. 1 km | 1.5 | 1 | 2.6 | 3 | 2.8 | 3.8 | 2.9 | 2.5 | 0.9 | 7 | 2 | 0 | 4 | 1 | 0 | * |
| I9 10 km | 2.3 | 1 | 1.8 | 3 | 2.8 | 2.0 | 2.8 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| I9 Maximum range of av | 2.0 | 1 | 1.4 | 2 | 1.5 | 2.6 | 2.2 | 1.8 | 0.5 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| I10. Include the effects | 2.0 | 1 | 1.0 | 3 | 2.5 | 2.2 | 1.9 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| I11. Provide realistic VI | 2.3 | 1 | 1.6 | 3 | 2.5 | 2.4 | 2.1 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| I12. Provide video covera | 2.5 | 1 | 2.3 | 3 | 2.8 | 2.2 | 2.2 | 2.3 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| J. ARTILLERY & MORTARS | | | | | | | | | | | | | | | | |
| J1. Loading rounds - proc | 3.1 | 1 | 3.0 | 3 | 0.5 | 3.0 | 2.6 | 2.3 | 1.0 | 7 | 2 | 0 | 5 | 0 | 0 | * |
| J2. Loading rounds - weig | 2.9 | 1 | 3.0 | 3 | 0.5 | 3.3 | 3.1 | 2.4 | 1.0 | 7 | 2 | 0 | 5 | 0 | 0 | * |
| J3. Loading rounds - load | 3.1 | 1 | 2.7 | 3 | 0.5 | 3.0 | 2.6 | 2.3 | 1.0 | 7 | 2 | 0 | 5 | 0 | 0 | * |
| J4. Laying the weapon | 3.0 | 1 | 3.0 | 3 | 1.0 | 2.5 | 2.0 | 2.2 | 0.8 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| J5. Firing the weapon - p | 2.7 | 1 | 2.3 | 3 | 1.0 | 2.4 | 2.1 | 2.1 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| J6. Firing the weapon - r | 2.9 | 1 | 3.3 | 3 | 1.0 | 2.6 | 3.0 | 2.4 | 0.9 | 7 | 2 | 0 | 5 | 0 | 0 | * |
| J7. Firing the weapon - f | 2.6 | 2 | 2.3 | 3 | 1.0 | 2.6 | 2.3 | 2.3 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| J8. Adjustment of fire | 1.6 | 2 | 2.0 | 2 | 0.7 | 1.8 | 1.2 | 1.6 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| J9. Target area cues for | 1.6 | 2 | 2.3 | 2 | 0.5 | 2.0 | 1.3 | 1.7 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| J10. Use of Battery Compu | 2.3 | 2 | 1.7 | 1 | 0.7 | 1.8 | 2.2 | 1.7 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| J11. Use of TACFIRE | 2.2 | 1 | 1.7 | 1 | 0.7 | 1.8 | 1.8 | 1.4 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | *** |
| J12. Simulate/replicate e | 2.5 | 1 | 1.3 | 2 | 1.0 | 2.2 | 2.8 | 1.8 | 0.7 | 7 | 3 | 3 | 1 | 0 | 0 | ** |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

TES PNS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J13. Simulate loss of com | 3.3 | 1 | 2.0 | 3 | 1.0 | 2.4 | 3.0 | 2.2 | 0.9 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| J14. Defense of area | 2.3 | 1 | 3.0 | 3 | 1.0 | 2.8 | 3.0 | 2.3 | 0.9 | 7 | 2 | 1 | 4 | 0 | 0 | * |
| J15. Counter battery fire | 2.8 | 1 | 2.3 | 2 | 1.0 | 2.0 | 2.2 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| J16. Direct fire | 2.0 | 1 | 1.7 | 2 | 1.0 | 2.0 | 2.0 | 1.7 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| J17. Improved munitions( | 2.3 | 1 | 1.0 | 2 | 1.0 | 2.2 | 1.8 | 1.6 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| J18. Selection, use, cons | 3.2 | 1 | 2.5 | 3 | 1.0 | 2.2 | 2.1 | 2.1 | 0.8 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| K. ARTILLERY & MORTAR EFFECTS | | | | | | | | | | | | | | | | |
| K1. Flash of incoming rou | 2.0 | 1 | 2.5 | 1 | 1.3 | 2.3 | 1.8 | 1.7 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| K2. Bang of incoming roun | 2.3 | 2 | 2.8 | 1 | 2.0 | 2.3 | 1.7 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| K3. Smoke of incoming rou | 2.3 | 2 | 2.5 | 1 | 2.0 | 2.0 | 1.8 | 2.0 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| K4. Simulated ground burs | 1.8 | 2 | 1.8 | 2 | 2.0 | 2.3 | 1.6 | 1.9 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| K5. Simulated air burst | 1.8 | 2 | 1.8 | 2 | 2.0 | 2.0 | 1.7 | 1.9 | 0.1 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| K6. Attrition of vehicles | 2.2 | 1 | 1.3 | 2 | 1.0 | 2.2 | 1.5 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| K7. Attrition of vehicle | 2.2 | 1 | 1.3 | 2 | 1.0 | 2.2 | 1.5 | 1.6 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| K8. Attrition of dismount | 2.2 | 1 | 1.5 | 2 | 1.0 | 2.5 | 1.5 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| K9. Suppression | 2.2 | 1 | 1.8 | 2 | 2.0 | 2.0 | 1.6 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| K10. Simulation of damage | 3.2 | 2 | 2.8 | 2 | 2.5 | 2.8 | 2.5 | 2.5 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 | |
| K11. Simulation of damage | 3.2 | 2 | 2.8 | 2 | 2.5 | 2.8 | 2.3 | 2.5 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| K12. Real-time casualty a | 1.5 | 1 | 1.0 | 1 | 1.0 | 2.2 | 1.5 | 1.3 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| K13. Adjustment of fire | 1.3 | 1 | 2.0 | 2 | 1.5 | 1.6 | 1.1 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| K14. Round-for-round-simu | 2.5 | 1 | 2.3 | 2 | 1.5 | 2.2 | 1.6 | 1.9 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| K15. Surprise | 2.8 | 1 | 2.0 | 1 | 1.5 | 2.8 | 2.1 | 1.9 | 0.7 | 7 | 3 | 2 | 2 | 0 | 0 | ** |
| K16. Time fidelity for re | 2.8 | 1 | 2.0 | 1 | 1.5 | 2.0 | 1.5 | 1.7 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| L. MINES | | | | | | | | | | | | | | | | |
| L1. Replicate the size of | 1.7 | 2 | 3.0 | 2 | 1.6 | 2.0 | 2.4 | 2.1 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| L2. Replicate the weight | 1.7 | 2 | 3.0 | 2 | 1.6 | 2.4 | 2.6 | 2.2 | 0.5 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L3. Replicate the trip me | 1.6 | 2 | 2.0 | 2 | 1.6 | 2.0 | 1.9 | 1.9 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| L4. Reproduce detection c | 1.6 | 2 | 2.0 | 2 | 1.4 | 1.8 | 1.6 | 1.8 | 0.2 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| L5. Simulate mines on a o | 1.9 | 2 | 3.0 | 2 | 1.8 | 2.6 | 2.0 | 2.2 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L6. Simulate mines on a g | 4.0 | 2 | 2.0 | 3 | 1.4 | 3.0 | 2.4 | 2.5 | 0.8 | 7 | 1 | 3 | 2 | 1 | 0 | |
| L7. Simulate the attritio | 1.2 | 2 | 2.5 | 2 | 1.2 | 2.2 | 1.6 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| L8. Simulate only the ove | 2.7 | 2 | 1.7 | 2 | 1.8 | 2.6 | 2.8 | 2.2 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| 19. Provide for simulatin | 2.7 | 2 | 4.0 | 3 | 2.0 | 2.8 | 2.2 | 2.7 | 0.7 | 7 | 0 | 3 | 3 | 1 | 0 | |
| L10. Provide for simulati | 2.0 | 2 | 3.0 | 3 | 1.6 | 2.6 | 2.2 | 2.3 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| L11. Provide for simulati | 1.7 | 2 | 3.0 | 3 | 1.8 | 2.4 | 2.2 | 2.3 | 0.5 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L12. Provide for simulati | 2.0 | 2 | 2.0 | 3 | 2.2 | 2.4 | 2.2 | 2.3 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| L13. Provide for simulati | 2.0 | 2 | 2.0 | 3 | 1.4 | 2.2 | 1.8 | 2.1 | 0.4 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| L14. Provide for simulati | 2.3 | 2 | 2.0 | 3 | 1.6 | 2.6 | 2.1 | 2.2 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L15. Provide real-time ca | 1.7 | 2 | 1.7 | 1 | 1.0 | 1.8 | 1.3 | 1.5 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| L16. Provides real-time c | 1.7 | 2 | 1.7 | 1 | 1.0 | 1.8 | 1.5 | 1.5 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| L17. Attrition of any pla | 1.9 | 2 | 2.0 | 2 | 1.2 | 1.8 | 1.8 | 1.8 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| L18. Attrition of only ma | 2.6 | 2 | 3.3 | 2 | 2.8 | 3.8 | 3.2 | 2.8 | 0.6 | 7 | 0 | 2 | 4 | 1 | 0 | |
| L19. Mine reuse after usi | 2.4 | 2 | 2.0 | 3 | 1.6 | 1.8 | 2.0 | 2.1 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| L20. Threat mine warfare | 1.6 | 2 | 1.7 | 3 | 1.6 | 1.8 | 1.4 | 1.9 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| M. NUCLEAR/BIOLOGICAL/CHEMICAL | | | | | | | | | | | | | | | | |
| M1. Training intended for | 2.4 | 2 | 2.3 | 1 | 2.3 | 3.8 | 2.1 | 2.3 | 0.8 | 7 | 1 | 5 | 0 | 1 | 0 | * |
| M2. Training intended for | 1.8 | 2 | 1.9 | 2 | 2.0 | 2.4 | 1.8 | 2.0 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| M3. NBC training exercise | 3.6 | 2 | 3.5 | 2 | 3.5 | 3.4 | 3.0 | 3.0 | 0.7 | 7 | 0 | 2 | 4 | 1 | 0 | |
| M4. Integrated N<B< and C | 1.6 | 2 | 1.7 | 2 | 2.5 | 2.2 | 1.6 | 1.9 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| M5. Use of notional units | 2.0 | 2 | 2.3 | 3 | 3.0 | 2.8 | 2.6 | 2.5 | 0.4 | 7 | 0 | 3 | 4 | 0 | 0 | |
| M6. Different NBC simulan | 1.4 | 2 | 2.2 | 3 | 2.5 | 2.2 | 2.3 | 2.2 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

TES PMS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M7. Use NBC warning and r | 1.6 | 2 | 2.0 | 3 | 1.3 | 2.0 | 1.5 | 1.9 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| M8. NBC monitoring and su | 1.4 | 2 | 2.0 | 3 | 1.8 | 2.3 | 1.8 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| M9. NBC simulation devic | 2.0 | 2 | 2.4 | 3 | 1.5 | 3.2 | 1.6 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| M10. NBC Simulation train | 1.4 | 2 | 2.0 | 3 | 1.8 | 2.8 | 2.1 | 2.2 | 0.5 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| M11. Flash/bang/smoke cue | 2.2 | 2 | 2.6 | 2 | 2.0 | 2.2 | 1.7 | 2.1 | 0.2 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| M12. Traveling through a | 1.2 | 2 | 2.1 | 2 | 1.5 | 2.2 | 1.5 | 1.8 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| M13. Nuclear training should be provided for unit size of: | | | | | | | | | | | | | | | | |
| M13. Squad | 1.6 | 2 | 2.2 | 2 | 1.8 | 2.8 | 1.5 | 2.0 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | ** |
| M13. Platoon | 1.6 | 2 | 2.2 | 2 | 1.8 | 2.7 | 1.6 | 2.0 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | ** |
| M13. Company | 1.8 | 2 | 1.7 | 2 | 1.8 | 2.5 | 1.5 | 1.9 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| M13. Battalion/task fo | 2.0 | 2 | 2.2 | 2 | 2.0 | 1.8 | 1.9 | 2.0 | 0.1 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| M13 Larger than battal | 2.4 | 2 | 2.8 | 3 | 2.3 | 2.8 | 2.8 | 2.6 | 0.3 | 7 | 0 | 3 | 4 | 0 | 0 | |
| M14. Nuclear simulation should provide for: | | | | | | | | | | | | | | | | |
| M14. Total dose | 1.8 | 2 | 2.5 | 3 | 2.0 | 2.4 | 1.7 | 2.2 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| M14. Dose rate | 2.0 | 2 | 2.5 | 3 | 2.0 | 3.0 | 1.7 | 2.3 | 0.5 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| M14. Dose rate and to | 1.8 | 2 | 2.0 | 3 | 2.0 | 3.0 | 2.2 | 2.3 | 0.5 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| M14 Armor protection | 2.2 | 2 | 2.5 | 3 | 2.0 | 2.4 | 1.7 | 2.3 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| M14 EMP/TREE simulati | 2.8 | 2 | 2.2 | 3 | 2.3 | 2.4 | 2.1 | 2.4 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| M15. Simulation of biolog | 2.8 | 1 | 3.1 | 2 | 2.7 | 2.2 | 2.2 | 2.3 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| M16. Simulation of biolog | 2.8 | 1 | 3.1 | 2 | 2.7 | 2.2 | 2.2 | 2.3 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| M17. Simulation of contamination transfer: | | | | | | | | | | | | | | | | |
| M17 To interiors of arm | 2.8 | 2 | 3.0 | 3 | 2.8 | 2.3 | 2.0 | 2.6 | 0.4 | 7 | 0 | 3 | 4 | 0 | 0 | |
| M17 From one area to | 2.8 | 2 | 2.6 | 3 | 2.3 | 2.3 | 1.9 | 2.4 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| M18. Provide surprise del | 2.0 | 2 | 1.7 | 2 | 1.3 | 1.8 | 2.0 | 1.8 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| M19. Provide surprise CS | 2.0 | 2 | 1.7 | 3 | 1.3 | 2.2 | 1.9 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| M20. Persistent simulant | 2.2 | 1 | 2.2 | 2 | 1.5 | 2.4 | 1.8 | 1.9 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| M21. Simulation of nonper | 2.0 | 1 | 2.3 | 2 | 1.8 | 2.6 | 1.5 | 1.9 | 0.5 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| M22. Simulation of persis | 2.0 | 1 | 2.3 | 2 | 1.8 | 2.2 | 1.7 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| M23. Delivery of chemical | 2.2 | 2 | 2.4 | 2 | 1.5 | 3.2 | 2.1 | 2.2 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| M24. Delivery of chemical | 2.2 | 2 | 2.1 | 2 | 1.3 | 3.0 | 1.8 | 2.1 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| M25. Real-time casualty a | 1.6 | 1 | 1.6 | 1 | 1.3 | 2.2 | 1.7 | 1.5 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | *** |
| M26. Training in all MOPP | 2.0 | 1 | 1.3 | 2 | 1.3 | 1.8 | 1.5 | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| N. MOUT | | | | | | | | | | | | | | | | |
| N1. Indication of simulat | 3.0 | 2 | 2.4 | 2 | 1.5 | 3.0 | 2.4 | 2.3 | 0.5 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| N2. Simulate the protecti | 2.8 | 2 | 2.2 | 2 | 1.5 | 2.6 | 2.0 | 2.2 | 0.4 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| N3. Simulate protection d | 2.8 | 1 | 2.3 | 2 | 1.8 | 2.6 | 2.2 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| N4. Casualties on personn | 1.7 | 2 | 2.4 | 2 | 1.8 | 1.8 | 2.1 | 2.0 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| N5. Simulate TES weapons | 2.2 | 1 | 2.2 | 2 | 1.8 | 2.6 | 1.7 | 1.9 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| N6. Engage at night | 1.2 | 2 | 2.0 | 2 | 1.3 | 2.0 | 1.6 | 1.7 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| N7. Engage through obscur | 1.2 | 2 | 2.0 | 2 | 1.5 | 2.2 | 1.8 | 1.8 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| N8. Engage at very close | 2.0 | 2 | 2.3 | 2 | 1.5 | 2.2 | 1.5 | 1.9 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| N9. Simulate attrition fr | 3.0 | 2 | 2.5 | 2 | 1.8 | 2.8 | 2.2 | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| N10. Emphasize the instru | 1.8 | 2 | 2.2 | 2 | 1.8 | 2.0 | 1.8 | 1.9 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| N11. Cues in MOUT: | | | | | | | | | | | | | | | | |
| N11. Weapon firing | 2.0 | 2 | 1.6 | 2 | 2.0 | 2.0 | 1.5 | 1.9 | 0.2 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| N11. Noise | 2.2 | 2 | 2.4 | 2 | 2.3 | 2.2 | 1.5 | 2.1 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | * |
| N11. Flash | 2.4 | 2 | 1.8 | 2 | 2.0 | 2.4 | 1.6 | 2.0 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | * |
| N11. Smoke | 2.4 | 2 | 1.8 | 2 | 2.0 | 2.6 | 1.6 | 2.1 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| N11. Pellets, dye or | 3.0 | 2 | 1.8 | 2 | 2.3 | 2.6 | 2.1 | 2.2 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| N11. Hit signatures | 2.2 | 2 | 2.0 | 2 | 2.3 | 2.2 | 1.6 | 2.0 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | * |
| N11. Smoke from burni | 3.0 | 2 | 2.4 | 2 | 2.0 | 2.6 | 2.5 | 2.4 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

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| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O. COMMAND AND CONTROL | | | | | | | | | | | | | | | | |
| O1. Instrument command an | 1.9 | 1 | 1.9 | 1 | 1.3 | 1.6 | 1.6 | 1.5 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | *** |
| O2. Simulate command and | 2.3 | 1 | 2.0 | 2 | 2.0 | 2.0 | 2.3 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| O3. Provide command and c | 2.0 | 1 | 2.4 | 3 | 1.7 | 2.2 | 2.3 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| O4. Simulate tactical com | 2.4 | 1 | 1.7 | 2 | 1.7 | 1.8 | 1.9 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| O5. Simulate or provide a | 2.4 | 1 | 2.0 | 2 | 2.3 | 1.8 | 1.5 | 1.9 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| O6. Provide TES data or v | 2.1 | 1 | 1.9 | 3 | 2.3 | 2.7 | 1.8 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| O7. Provide TES communica | 2.3 | 1 | 2.3 | 3 | 2.3 | 2.5 | 1.8 | 2.2 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| P. COMBAT SUPPORT | | | | | | | | | | | | | | | | |
| P1. Instrument combat sup | 1.8 | 2 | 2.7 | 2 | 1.0 | 3.0 | 2.6 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| P2. Instrument combat sup | 1.8 | 2 | 3.2 | 2 | 1.5 | 3.6 | 2.7 | 2.4 | 0.7 | 7 | 1 | 3 | 2 | 1 | 0 | * |
| P3. Instrument all potent | 2.0 | 2 | 2.2 | 2 | 1.5 | 2.8 | 2.1 | 2.1 | 0.4 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| P4. Simulate combat suppo | 2.2 | 2 | 2.2 | 2 | 2.0 | 3.2 | 2.8 | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| P5. Provide logistics rea | 1.6 | 1 | 1.8 | 2 | 2.0 | 1.7 | 1.6 | 1.7 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| P6. Provide for field med | 1.4 | 1 | 2.2 | 2 | 2.0 | 2.4 | 2.1 | 1.9 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| P7. Provide for problems | 1.2 | 1 | 2.3 | 2 | 2.0 | 2.2 | 2.1 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| P8. Provide for problems | 1.2 | 1 | 2.0 | 2 | 2.0 | 2.2 | 1.8 | 1.7 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| P9. Provide for problems | 1.8 | 1 | 2.0 | 2 | 2.0 | 2.0 | 1.8 | 1.8 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| Q. COMMUNICATION DISRUPTION | | | | | | | | | | | | | | | | |
| Q1. Provide for the simul | 1.8 | 1 | 1.9 | 2 | 1.6 | 2.3 | 2.0 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| Q2. Provide for the actua | 2.5 | 1 | 1.6 | 2 | 2.2 | 2.5 | 2.8 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Q3. Use actual RF jamming | 2.0 | 1 | 2.1 | 1 | 1.5 | 2.8 | 1.8 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| Q4. Disrupt communication | 2.0 | 1 | 1.7 | 3 | 2.5 | 3.0 | 2.7 | 2.3 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Q5. Disrupt only selected | 2.3 | 1 | 2.9 | 2 | 2.3 | 3.2 | 2.7 | 2.3 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Q6. Automatically attrit | 2.2 | 1 | 2.6 | 2 | 2.3 | 3.2 | 3.0 | 2.3 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Q7. Penalize excessive tr | 1.5 | 1 | 1.7 | 2 | 2.5 | 2.8 | 2.1 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| Q8. Simulate communicatio | 2.3 | 1 | 2.7 | 2 | 2.7 | 2.5 | 2.0 | 2.2 | 0.5 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| Q9. Allow simulated repai | 2.7 | 1 | 2.7 | 2 | 3.0 | 3.2 | 2.1 | 2.4 | 0.7 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| Q10. Provide for antenna | 2.7 | 1 | 2.3 | 2 | 2.3 | 2.8 | 2.4 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| Q11. Simulate EMI on elec | 2.5 | 1 | 2.0 | 2 | 2.0 | 2.8 | 2.3 | 2.1 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Q12. Simulate EMI on comp | 2.5 | 1 | 1.7 | 2 | 2.0 | 2.8 | 2.3 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| R. OPFOR | | | | | | | | | | | | | | | | |
| R0. OPFOR is not necessar | 1.0 | | 0.0 | | | 1.5 | | 0.8 | 0.6 | 3 | 2 | 0 | 0 | 0 | 0 | *** |
| R1. Threat maneuver tacti | 1.3 | 1 | 1.0 | 1 | 1.0 | 1.8 | 1.4 | 1.2 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 | *** |
| R2. Actual OPFOR vehicles | 3.6 | 2 | 2.3 | 3 | 2.0 | 1.8 | 3.1 | 2.5 | 0.6 | 7 | 0 | 4 | 2 | 1 | 0 | |
| R3. VISMODS for OPFOR veh | 2.9 | 1 | 1.7 | 2 | 2.0 | 1.7 | 1.8 | 1.8 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| R4. Actual threat weapons | 3.0 | 2 | 2.4 | 3 | 2.0 | 2.8 | 2.7 | 2.6 | 0.4 | 7 | 0 | 3 | 4 | 0 | 0 | |
| R5. Threat weapons charac | 2.0 | 1 | 1.5 | 2 | 2.0 | 1.8 | 1.8 | 1.7 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| R6. Threat weapon performance: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| R6. Available capabili | 1.3 | 2 | 1.6 | 2 | 1.5 | 2.5 | 1.5 | 1.8 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| R6. Latest (classified | 1.8 | 1 | 1.2 | 3 | 2.0 | 2.2 | 2.1 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| R7. Simulation of threat target vulnerability: | | | | | | | | | | | | | | | | |
| R7. Available ( unclas | 1.3 | 2 | 1.6 | 2 | 1.5 | 2.0 | 1.5 | 1.7 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| R7. Latest (classified | 1.8 | 1 | 1.6 | 3 | 2.0 | 1.7 | 2.2 | 1.9 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| R8. Threat uniforms | 2.6 | 1 | 2.4 | 2 | 1.5 | 2.0 | 2.1 | 1.9 | 0.5 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| S. OBSCURATION | | | | | | | | | | | | | | | | |
| S1. Shoot through obscura | 1.6 | 1 | 1.7 | 2 | 1.8 | 1.4 | 1.8 | 1.6 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| S2. Sight through obscura | 1.6 | 1 | 2.0 | 2 | 1.8 | 1.6 | 2.0 | 1.7 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| S3. Shoot through soft co | 1.8 | 1 | 1.9 | 2 | 2.4 | 2.2 | 2.0 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| S4. Provide IR-opaque tra | 3.0 | 1 | 1.8 | 2 | 2.3 | 3.0 | 2.2 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| S5. Simulate only the eff | 3.0 | 2 | 2.5 | 2 | 2.0 | 3.3 | 2.9 | 2.5 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | |

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| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S6. Simulate delivery of | 2.6 | 2 | 2.1 | 1 | 2.0 | 2.5 | 2.1 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| S7. Simulate delivery of | 2.6 | 2 | 2.4 | 1 | 2.0 | 2.0 | 2.2 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| T. SIGNATURES | | | | | | | | | | | | | | | | |
| T1. Hit flash | 1.6 | 1 | 1.3 | 3 | 2.0 | 2.2 | 1.5 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| T2. Kill smoke | 1.6 | 1 | 1.4 | 3 | 2.0 | 2.3 | 1.4 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| T3. Weapon flash | 2.0 | 1 | 2.0 | 1 | 2.0 | 2.2 | 1.5 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| T4. Weapon smoke | 2.0 | 1 | 1.7 | 1 | 1.5 | 2.3 | 1.4 | 1.6 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| T5. Weapon bang | 1.7 | 1 | 1.6 | 3 | 2.0 | 1.8 | 1.3 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| T6. Tracers | 1.7 | 1 | 1.7 | 3 | 2.0 | 1.8 | 1.3 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| T7. Burst on target | 2.0 | 1 | 2.1 | 3 | 2.0 | 1.8 | 1.3 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| T8. Incoming artillery or | 2.0 | 1 | 2.7 | 3 | 2.5 | 1.8 | 1.8 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| T9. Incoming artillery or | 2.0 | 1 | 2.1 | 1 | 2.0 | 1.8 | 1.4 | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| T10. Incoming artillery o | 1.9 | 1 | 2.1 | 1 | 2.0 | 2.3 | 1.4 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| T11. Mine flash | 1.9 | 1 | 2.1 | 1 | 2.0 | 2.3 | 1.3 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| T12. Mine bang | 1.9 | 1 | 2.1 | 1 | 2.0 | 2.5 | 1.5 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| T13. Mine smoke | 1.9 | 1 | 2.5 | 1 | 2.0 | 2.4 | 1.8 | 1.8 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| T14. Different signatures | 1.9 | 1 | 2.2 | 1 | 2.0 | 2.4 | 1.6 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| T15. Different signatures | 1.9 | 1 | 2.3 | 1 | 2.0 | 2.4 | 1.9 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| T16. Signatures as cues f | 1.7 | 1 | 1.4 | 2 | 2.0 | 1.7 | 2.0 | 1.7 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| T17. Signatures as cues f | 2.3 | 1 | 1.9 | 2 | 2.0 | 1.8 | 2.3 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| T18. Signatures through s | 2.0 | 1 | 1.4 | 2 | 2.0 | 1.8 | 1.7 | 1.7 | 0.3 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| U. ATTRITION | | | | | | | | | | | | | | | | |
| U1. Multiple levels of hi | 2.3 | 2 | 1.9 | 4 | 2.3 | 1.8 | 1.5 | 2.2 | 0.8 | 7 | 1 | 5 | 0 | 1 | 0 | * |
| U2. Higher probability of | 2.3 | 1 | 1.7 | 2 | 1.8 | 1.8 | 1.5 | 1.7 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| U3. Hit quadrant on a veh | 2.1 | 2 | 1.9 | 4 | 2.0 | 1.7 | 1.5 | 2.2 | 0.8 | 7 | 1 | 5 | 0 | 1 | 0 | * |
| U4. The effect on the pro | 2.0 | 1 | 1.6 | 3 | 2.3 | 2.7 | 1.9 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| U5. Multiple levels on in | 2.6 | 2 | 2.6 | 4 | 2.5 | 3.2 | 2.4 | 2.8 | 0.6 | 7 | 0 | 3 | 3 | 1 | 0 | |
| U6. Head shot on individu | 2.6 | 2 | 2.1 | 4 | 2.5 | 2.8 | 2.2 | 2.6 | 0.6 | 7 | 0 | 4 | 2 | 1 | 0 | |
| U7. Indication of who sho | 1.9 | 2 | 1.6 | 1 | 1.8 | 2.8 | 1.8 | 1.8 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| U8. Distinguish/identify | 1.9 | 2 | 1.6 | 2 | 2.3 | 2.5 | 1.9 | 2.0 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | * |
| V. CASUALTY ASSESSMENT | | | | | | | | | | | | | | | | |
| V1. For vehicles, loss of | 2.0 | 1 | 1.4 | 2 | 1.5 | 1.8 | 1.6 | 1.6 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| V2. Loss of radio | 2.7 | 2 | 2.1 | 2 | 2.5 | 2.5 | 2.2 | 2.3 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| V3. Attrition of individu | 1.4 | 2 | 1.9 | 2 | 2.0 | 2.8 | 1.7 | 2.0 | 0.4 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| V4. Casualty assessed aut | 2.4 | 2 | 2.3 | 1 | 2.5 | 2.5 | 1.5 | 2.0 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | * |
| V5. Indication for the me | 3.0 | 2 | 2.4 | 3 | 2.5 | 3.0 | 2.6 | 2.6 | 0.4 | 7 | 0 | 3 | 4 | 0 | 0 | |
| V6. Elimination of contro | 3.3 | 2 | 2.4 | 1 | 2.5 | 3.3 | 2.9 | 2.5 | 0.8 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| W. INTEROPERABILITY | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| W1. MILES | 1.4 | 2 | 1.4 | 1 | 1.3 | 1.7 | 1.3 | 1.4 | 0.3 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| W2. UCOFT, or similar cre | 2.3 | 2 | 2.5 | 1 | 3.0 | 1.8 | 2.9 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| W3. TWGSS, or similar gun | 2.3 | 1 | 2.5 | 1 | 3.0 | 2.2 | 1.4 | 1.9 | 0.7 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| W4. ARTBASS, or other sta | 2.2 | 1 | 2.3 | 1 | 3.0 | 2.2 | 2.9 | 2.1 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| W5. Test instrumentation | 2.0 | 1 | 2.0 | 1 | 2.0 | 2.3 | 2.3 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| W6. Other NATO TES system | 1.8 | 1 | 2.3 | 3 | 2.7 | 2.5 | 2.4 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| W7. Future new equipment | 2.0 | 1 | 1.3 | 1 | 1.8 | 2.2 | 1.6 | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| W8. Future improvements t | 1.8 | 2 | 1.3 | 1 | 1.8 | 2.2 | 1.5 | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| W9. Future threat equipme | 2.5 | 2 | 1.0 | 1 | 1.8 | 1.8 | 1.6 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| | | | | | | | | | | | | | | | | *** |
| X. CHEATING | | | | | | | | | | | | | | | | |
| X0. Cheating is not important in design of future TES system | | | | | | | | | | | | | | | | |
| X1. System should be as c | 1.8 | 2 | 1.3 | 1 | 1.8 | 1.2 | 1.5 | 1.5 | 0.3 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| X2. TES systems should di | 2.4 | 2 | 1.7 | 2 | 2.0 | 1.8 | 1.7 | 1.9 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 | ** |

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| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X3. Use of MILES-type key | 2.0 | 2 | 1.8 | 2 | 2.7 | 2.3 | 2.4 | 2.2 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| X4. Equipment should be m | 2.0 | 2 | 1.9 | 1 | 2.0 | 1.2 | 1.8 | 1.7 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| X5. The number of soldier | 2.4 | 2 | 1.7 | 1 | 1.8 | 2.3 | 1.8 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| X6. More functions should | 4.2 | 2 | 3.7 | 3 | 3.5 | 2.8 | 3.7 | 3.3 | 0.7 | 7 | 0 | 1 | 3 | 3 | 0 | xxx |
| Y. CONTROLLERS | | | | | | | | | | | | | | | | |
| Y1. Control the flow of t | 1.7 | 2 | 2.0 | 1 | 2.0 | 2.0 | 2.1 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| Y2. Arbitrate problems an | 2.0 | 2 | 2.0 | 1 | 2.3 | 1.7 | 1.8 | 1.8 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| Y3. Evaluate trainees | 3.2 | 2 | 1.7 | 3 | 2.3 | 2.2 | 2.9 | 2.5 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| Y4. Assess casualties | 1.5 | 2 | 1.7 | 3 | 2.8 | 2.5 | 2.6 | 2.3 | 0.5 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Y5. Prevent cheating | 2.3 | 2 | 1.6 | 2 | 2.5 | 1.8 | 2.2 | 2.1 | 0.3 | 7 | 0 | 7 | 0 | 0 | 0 | * |
| Y6. Emphasis should be pl | 2.7 | 2 | 1.3 | 2 | 1.8 | 1.8 | 1.4 | 1.9 | 0.4 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| Y7. More use should be ma | 3.8 | 2 | 3.5 | 4 | 3.7 | 4.3 | 4.5 | 3.7 | 0.8 | 7 | 0 | 1 | 1 | 5 | 0 | xxx |
| Y8. TES systems should be | 2.3 | 2 | 1.4 | 1 | 1.5 | 2.6 | 1.8 | 1.8 | 0.5 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| Z. POSITION LOCATION | | | | | | | | | | | | | | | | |
| Z1. Location of every pla | 3.7 | 2 | 3.0 | 2 | 3.0 | 2.8 | 2.8 | 2.8 | 0.6 | 7 | 0 | 2 | 4 | 1 | 0 | |
| Z2. Location of major wea | 2.1 | 2 | 2.3 | 1 | 1.4 | 1.8 | 2.2 | 1.8 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| Z3. Location of all but d | 3.1 | 2 | 2.9 | 2 | 2.2 | 2.0 | 3.0 | 2.5 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| Z4. Location to within 10 | 3.0 | 3 | 2.0 | 2 | 2.3 | 2.4 | 2.3 | 2.4 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| Z5. Location to within 10 | 3.3 | 2 | 2.4 | 1 | 1.8 | 2.8 | 2.5 | 2.3 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Z6. Location to within 1 | 3.7 | 3 | 3.6 | 3 | 3.0 | 3.2 | 3.5 | 3.3 | 0.3 | 7 | 0 | 0 | 5 | 2 | 0 | xxx |
| Z7. Include altitude as w | 3.1 | 3 | 2.1 | 2 | 2.8 | 2.8 | 3.4 | 2.7 | 0.5 | 7 | 0 | 2 | 5 | 0 | 0 | |
| Z8. Include orientation o | 3.3 | 3 | 2.4 | 3 | 2.4 | 2.8 | 2.6 | 2.8 | 0.3 | 7 | 0 | 2 | 5 | 0 | 0 | |
| Z9. Include orientation o | 3.0 | 3 | 2.7 | 3 | 2.5 | 3.0 | 2.5 | 2.8 | 0.2 | 7 | 0 | 2 | 5 | 0 | 0 | |
| Z0. Location continuously | 2.6 | 3 | 2.1 | 1 | 2.0 | 2.6 | 2.2 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| Z1. Location needed only | 3.7 | 3 | 2.6 | 2 | 3.6 | 2.8 | 2.9 | 2.9 | 0.5 | 7 | 0 | 1 | 4 | 2 | 0 | |
| AA. INTERVISIBILITY | | | | | | | | | | | | | | | | |
| AA0. Intervisibility not | 1.0 | | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 5 | 5 | 0 | 0 | 0 | 0 | *** |
| AA1. Include intervisibil | 2.6 | 1 | 2.2 | 4 | 2.0 | 2.5 | 2.7 | 2.4 | 0.8 | 7 | 1 | 3 | 2 | 1 | 0 | * |
| AA2. Include intervisibil | 2.4 | 1 | 2.0 | 3 | 2.7 | 2.8 | 2.8 | 2.4 | 0.6 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| AA3. Provide intervisibil | 2.8 | 1 | 2.8 | 2 | 3.0 | 2.8 | 3.3 | 2.5 | 0.7 | 7 | 1 | 1 | 5 | 0 | 0 | |
| BB. DATA COLLECTION | | | | | | | | | | | | | | | | |
| BB1. Simplify field equip | 2.3 | 2 | 2.6 | 4 | 2.3 | 3.6 | 3.2 | 2.9 | 0.7 | 7 | 0 | 3 | 2 | 2 | 0 | |
| BB2. Provide for on-board | 2.4 | 2 | 1.7 | 4 | 2.0 | 2.0 | 1.8 | 2.3 | 0.7 | 7 | 0 | 6 | 0 | 1 | 0 | * |
| BB3. Provide for real-tim | 2.4 | 1 | 1.8 | 2 | 2.0 | 2.0 | 1.8 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| BB4. Provide video taping | 3.3 | 1 | 2.3 | 1 | 2.3 | 2.7 | 2.5 | 2.2 | 0.8 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| BB5. Provide video taping | 3.1 | 1 | 2.7 | 4 | 2.7 | 2.7 | 1.9 | 2.6 | 0.9 | 7 | 1 | 1 | 4 | 1 | 0 | |
| BB6. Provide computer gra | 2.3 | 1 | 2.2 | 2 | 2.0 | 2.5 | 2.3 | 2.0 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 | * |
| BB7. Include player posit | 2.3 | 1 | 2.5 | 2 | 2.3 | 2.4 | 2.4 | 2.1 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 | * |
| BB8. Include firing weapo | 2.3 | 1 | 2.2 | 2 | 2.0 | 2.2 | 1.8 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| CC. SIZE | | | | | | | | | | | | | | | | |
| CC1. Future TES should be | 2.0 | 2 | 2.0 | 1 | 1.5 | 2.8 | 1.9 | 1.9 | 0.5 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| CC2. Size is more importa | 3.2 | 2 | 3.2 | 2 | 3.7 | 2.8 | 4.1 | 3.0 | 0.7 | 7 | 0 | 2 | 3 | 2 | 0 | |
| CC3. Reduce size to impro | 2.0 | 1 | 2.8 | 1 | 2.5 | 2.6 | 2.0 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | ** |
| CC4. Eliminate helmet det | 3.0 | 1 | 3.2 | 1 | 3.8 | 3.7 | 3.3 | 2.7 | 1.1 | 7 | 2 | 0 | 3 | 2 | 0 | |
| DD. WEIGHT | | | | | | | | | | | | | | | | |
| DD1. The maximum wt. for TES equipment carried by infantry must be: | | | | | | | | | | | | | | | | |
| DD1. Less than 2 pound | 1.7 | 2 | 1.7 | 1 | 1.6 | 2.0 | 1.7 | 1.7 | 0.3 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| DD1. Less than 10 poun | 3.7 | 2 | 2.3 | 5 | 4.8 | 2.6 | 2.6 | 3.3 | 1.1 | 7 | 0 | 2 | 2 | 1 | 2 | xxx |
| DD1. Less than 20 poun | 3.9 | 2 | 5.0 | 5 | 4.8 | 3.8 | 4.6 | 4.1 | 1.0 | 7 | 0 | 1 | 0 | 2 | 4 | xxx |
| DD2. The maximum weight for TES equipment on an helicopter must be: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| DD2. Less than 50 poun | 2.8 | 1 | 1.6 | 1 | 1.5 | 1.0 | 1.6 | 1.5 | 0.6 | 7 | 4 | 2 | 1 | 0 | 0 | ** |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

TFS PNS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DD2. Less than 200 pou | 4.8 | 1 | 1.6 | 5 | 5.0 | 4.0 | 4.6 | 3.7 | 1.6 | 7 | 1 | 1 | 0 | 1 | 4 | xxx |
| DD3. The maximum weight for TFS equipment on a fixed-wing a/c must be: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| DD3. Less than 50 poun | 2.8 | 1 | 1.0 | 1 | 2.0 | 1.0 | 1.9 | 1.5 | 0.6 | 7 | 4 | 2 | 1 | 0 | 0 | ** |
| DD3. Less than 200 pou | 4.7 | 1 | 1.7 | 5 | 3.0 | 4.0 | 4.2 | 3.4 | 1.4 | 7 | 1 | 1 | 1 | 2 | 2 | xxx |
| EE. TYPE OF ELECTRICAL POWER | | | | | | | | | | | | | | | | |
| EE1. Use of vehicle power | 2.0 | 2 | 1.3 | 5 | 1.2 | 2.6 | 1.5 | 2.2 | 1.2 | 7 | 3 | 2 | 1 | 0 | 1 | * |
| EE2. Use of special high | 3.2 | 2 | 3.2 | 1 | 4.0 | 3.6 | 3.3 | 2.9 | 1.0 | 7 | 1 | 1 | 3 | 2 | 0 | |
| EE3. Use standard commerc | 2.7 | 3 | 3.5 | 5 | 2.0 | 3.0 | 2.6 | 3.1 | 0.9 | 7 | 0 | 1 | 5 | 0 | 1 | xxx |
| EE4. Use rechargeable bat | 3.0 | 2 | 2.0 | 5 | 2.0 | 2.4 | 2.1 | 2.6 | 1.0 | 7 | 0 | 5 | 1 | 0 | 1 | |
| EE5. Minimize use of batt | 2.1 | 2 | 2.4 | 5 | 1.8 | 2.2 | 1.4 | 2.4 | 1.1 | 7 | 1 | 5 | 0 | 0 | 1 | * |
| EE6. Use size and quantit | 2.7 | 1 | 2.8 | 1 | 1.5 | 2.4 | 1.8 | 1.9 | 0.7 | 7 | 3 | 2 | 2 | 0 | 0 | ** |
| FF. BUILT-IN TEST (BITE) | | | | | | | | | | | | | | | | |
| FF0. BITE is not importan | 1.0 | | | | 1.0 | 1.0 | | 1.0 | 0.0 | 3 | 3 | 0 | 0 | 0 | 0 | *** |
| FF1. BITE operable by use | 2.6 | 2 | 1.2 | 5 | 3.5 | 1.8 | 2.0 | 2.6 | 1.2 | 7 | 1 | 3 | 2 | 0 | 1 | |
| FF2. BITE operable by rep | 2.4 | 2 | 3.6 | 1 | 1.5 | 2.8 | 3.5 | 2.4 | 0.9 | 7 | 2 | 2 | 1 | 2 | 0 | * |
| FF3. Activates automatica | 2.6 | 3 | 2.1 | 2 | 2.5 | 2.0 | 2.5 | 2.4 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| FF4. System-level BITE (G | 2.4 | 2 | 1.9 | 1 | 2.5 | 1.3 | 3.2 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | * |
| FF5. System-level BITE (w | 2.8 | 2 | 2.0 | 2 | 2.0 | 2.3 | 2.1 | 2.2 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| FF6. Component level BITE | 3.0 | 2 | 2.3 | 2 | 2.5 | 2.3 | 2.4 | 2.4 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| GG. INSTALLATION | | | | | | | | | | | | | | | | |
| GG1. More permanent insta | 2.9 | 2 | 2.5 | 1 | 4.5 | 3.0 | 2.2 | 2.6 | 1.0 | 7 | 1 | 3 | 2 | 1 | 0 | |
| GG2. Much easier to insta | 2.3 | 2 | 1.2 | 1 | 2.2 | 2.3 | 1.8 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| GG3. Installation at a tE | 3.4 | 2 | 4.6 | 1 | 4.5 | 3.4 | 4.4 | 3.3 | 1.3 | 7 | 1 | 1 | 2 | 2 | 1 | xxx |
| GG4. Installation anywher | 2.6 | 2 | 1.7 | 5 | 2.0 | 1.5 | 1.3 | 2.3 | 1.2 | 7 | 2 | 3 | 1 | 0 | 1 | * |
| GG5. Installation by civi | 4.1 | 2 | 3.7 | 1 | 3.3 | 3.8 | 4.0 | 3.1 | 1.1 | 7 | 1 | 1 | 1 | 4 | 0 | xxx |
| GG6. Installation by mili | 2.3 | 2 | 2.0 | 5 | 2.0 | 1.4 | 1.4 | 2.3 | 1.1 | 7 | 2 | 4 | 0 | 0 | 1 | * |
| GG7. Installation by spec | 4.3 | 2 | 4.3 | 1 | 4.8 | 4.3 | 4.7 | 3.6 | 1.4 | 7 | 1 | 1 | 0 | 3 | 2 | xxx |
| HH. ISSUE | | | | | | | | | | | | | | | | |
| HH1. At least some compon | 4.3 | 2 | 4.1 | 5 | 4.4 | 4.7 | 4.4 | 4.1 | 0.9 | 7 | 0 | 1 | 0 | 4 | 2 | xxx |
| HH2. Future TFS should be | 2.9 | 2 | 2.0 | 5 | 1.8 | 2.8 | 2.7 | 2.7 | 1.0 | 7 | 0 | 3 | 3 | 0 | 1 | |
| HH3. Future TFS should be | 2.3 | 2 | 4.0 | 1 | 3.2 | 2.7 | 2.7 | 2.6 | 0.9 | 7 | 1 | 2 | 3 | 1 | 0 | |
| HH4. TFS equipment issued | 2.4 | 2 | 2.6 | 1 | 2.8 | 3.0 | 2.1 | 2.3 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| HH5. Emphasis should be p | 3.6 | 2 | 3.0 | 5 | 3.8 | 2.0 | 2.8 | 3.2 | 1.0 | 7 | 0 | 2 | 2 | 2 | 1 | xxx |
| HH6. TFS equipment sets s | 3.3 | 2 | 2.1 | 5 | 2.5 | 1.7 | 1.7 | 2.6 | 1.1 | 7 | 0 | 5 | 1 | 0 | 1 | |
| HH7. Each battalion shoul | 3.4 | 2 | 2.3 | 5 | 3.0 | 2.2 | 2.5 | 2.9 | 1.0 | 7 | 0 | 3 | 3 | 0 | 1 | |
| II. MAINTENANCE | | | | | | | | | | | | | | | | |
| II1. TFS components desig | 2.7 | 2 | 2.0 | 5 | 1.3 | 2.0 | 1.5 | 2.3 | 1.2 | 7 | 2 | 3 | 1 | 0 | 1 | * |
| II2. TFS sys. designed for easy fault isolation: | | | | | | | | | | | | | | | | |
| II2. By troops | 2.9 | 2 | 1.9 | 5 | 2.7 | 3.0 | 1.7 | 2.7 | 1.0 | 7 | 0 | 3 | 3 | 0 | 1 | |
| II2. By TASC | 2.6 | 3 | 3.4 | 1 | 2.3 | 2.2 | 2.7 | 2.5 | 0.7 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| II2. By CLS only | 4.3 | 3 | 4.1 | 1 | 3.0 | 3.4 | 3.7 | 3.2 | 1.0 | 7 | 1 | 0 | 3 | 3 | 0 | xxx |
| II3. Component replacemen | 2.4 | 2 | 1.9 | 5 | 1.8 | 1.5 | 1.7 | 2.3 | 1.1 | 7 | 1 | 5 | 0 | 0 | 1 | * |
| II4. Component replacemen | 2.6 | 2 | 3.3 | 1 | 3.3 | 3.3 | 2.8 | 2.6 | 0.8 | 7 | 1 | 1 | 5 | 0 | 0 | |
| II5. Component repair by | 2.4 | 2 | 3.3 | 1 | 3.0 | 2.7 | 2.4 | 2.4 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| II6. Repair by military p | 2.0 | 2 | 2.3 | 5 | 2.3 | 2.4 | 1.9 | 2.6 | 1.0 | 7 | 0 | 6 | 0 | 0 | 1 | |
| II7. Repair by civilian p | 3.1 | 2 | 3.2 | 1 | 2.7 | 3.4 | 2.3 | 2.5 | 0.8 | 7 | 1 | 2 | 4 | 0 | 0 | |
| JJ. TFS EQUIPMENT TRAINING | | | | | | | | | | | | | | | | |
| JJ1. Introduction to TFS | 1.9 | 2 | 2.7 | 2 | 2.2 | 2.8 | 2.1 | 2.2 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| JJ2. Expand TFS training | 2.6 | 2 | 2.3 | 5 | 2.0 | 2.5 | 2.0 | 2.6 | 1.0 | 7 | 0 | 5 | 1 | 0 | 1 | |
| JJ3. Expand TFS training | 2.7 | 2 | 2.5 | 5 | 2.6 | 2.7 | 2.0 | 2.8 | 0.9 | 7 | 0 | 3 | 3 | 0 | 1 | |
| JJ4. Provide more trainin | 3.4 | 2 | 2.6 | 5 | 2.7 | 2.2 | 2.4 | 2.9 | 1.0 | 7 | 0 | 3 | 3 | 0 | 1 | |

RESULTS OF ONS QUESTIONNAIRE FOR ARMY SCHOOLS

TES PMS QUESTIONNAIRE RESULTS EACH SCHOOL HAS ONE VOTE 7 NOV. 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JJ5. Provide more trainin | 3.1 | 2 | 2.5 | 5 | 2.3 | 2.2 | 2.1 | 2.8 | 1.0 | 7 | 0 | 5 | 1 | 0 | 1 | |
| JJ6. Provide videotapes f | 2.7 | 2 | 2.1 | 5 | 2.2 | 1.7 | 1.7 | 2.5 | 1.1 | 7 | 0 | 5 | 1 | 0 | 1 | * |
| JJ7. Provide simulators o | 3.4 | 2 | 2.6 | 5 | 2.6 | 3.0 | 2.4 | 3.0 | 0.9 | 7 | 0 | 2 | 4 | 0 | 1 | |
| JJ8. Provide training aid | 2.9 | 2 | 2.2 | 5 | 2.4 | 2.0 | 2.1 | 2.6 | 1.0 | 7 | 0 | 5 | 1 | 0 | 1 | |
| KK. TARGETS | | | | | | | | | | | | | | | | |
| KK1. Cues to indicate hit | 1.9 | 2 | 1.3 | 2 | 1.3 | 1.8 | 1.3 | 1.7 | 0.3 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| KK2. Hit sensors on targe | 1.7 | 2 | 1.5 | 3 | 1.3 | 1.7 | 1.2 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| KK3. Targets with shootba | 1.7 | 2 | 1.3 | 3 | 2.0 | 1.8 | 1.8 | 1.9 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| KK4. Real-time casualty a | 1.4 | 2 | 1.3 | 1 | 1.0 | 1.7 | 1.6 | 1.4 | 0.3 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| KK5. Probability of kill | 2.0 | 2 | 1.8 | 2 | 2.0 | 2.0 | 1.6 | 1.9 | 0.1 | 7 | 0 | 7 | 0 | 0 | 0 | ** |
| KK6. Wpn and target pairi | 2.2 | 2 | 2.0 | 2 | 2.7 | 2.7 | 2.1 | 2.2 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| KK7. Wpn and target pairi | 1.8 | 2 | 1.8 | 2 | 2.3 | 2.7 | 1.6 | 2.0 | 0.3 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| KK8. Wpn and target pairi | 1.8 | 2 | 1.4 | 2 | 2.0 | 2.7 | 1.6 | 1.9 | 0.4 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| | | 4 | | 13 | | | | AVERAGE | STAND | NO. | | | | | | |

RESULTS OF THE PNS QUESTIONNAIRE
25-Sep-87
RESULTS FOR FIELD UNITS

A = 0.00 to 1.50
B = 1.51 to 2.50
C = 2.51 to 3.50
D = 3.51 to 4.50
E = 4.51 to 5.00

| The following tabulation are the results for the active field units. Each active unit is given equal weight. | ACTIVE FIELD UNITS: 9th INF mtzd | 7thInf. AVER | I Corps HQ. 63 | 6 Inf AVER | 18th Air | FORSCOM AVER | 3RD CORPS AVER | 1ST CAV DIV AVER | AVERAGE | STAND DEV | NO. REPLIES | GRADE DISTRIBUTION A | B | C | D | E | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 39 | 40-58 | 59 | 60,60 | 61 | 62-65 | 125,131 | 126-130 | | | | | | | | | |
| A. TYPE OF TRAINING | | | | | | | | | | | | | | | | | |
| A1. Maneuver | 1 | 1.5 | 1 | 1.5 | 1 | 1.3 | 1.0 | 1.3 | 1.2 | 0.2 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| A2. Gunnery | 1 | 1.6 | 1 | 1.5 | 1 | 1.0 | 1.0 | 3.3 | 1.4 | 0.7 | 8 | 6 | 1 | 1 | 0 | 0 | *** |
| A3. Command/leader | 1 | 2.3 | 2 | 2.0 | 2 | 2.3 | 2.0 | 2.2 | 2.0 | 0.4 | 8 | 1 | 7 | 0 | 0 | 0 | ** |
| A4. Command and Control S | 2 | 2.6 | 2 | 2.0 | 3 | 2.0 | 1.5 | 2.3 | 2.2 | 0.4 | 8 | 1 | 5 | 2 | 0 | 0 | * |
| A5. Crew Skills | 2 | 1.9 | 1 | 1.5 | 2 | 2.0 | 2.0 | 2.2 | 1.8 | 0.4 | 8 | 2 | 6 | 0 | 0 | 0 | ** |
| A6. Technical Skills | 2 | 2.4 | 2 | 2.0 | 2 | 2.3 | 2.0 | 2.3 | 2.1 | 0.2 | 8 | 0 | 8 | 0 | 0 | 0 | * |
| A7. Combat Support | 3 | 2.8 | 2 | 3.0 | 2 | 2.3 | 2.5 | 2.0 | 2.4 | 0.4 | 8 | 0 | 5 | 3 | 0 | 0 | * |
| A8. Combat service suppor | 3 | 3.2 | 2 | 3.0 | 3 | 2.8 | 2.5 | 2.5 | 2.7 | 0.4 | 8 | 0 | 3 | 5 | 0 | 0 | |
| A9. Multi-Echelon | 2 | 2.0 | 1 | 3.0 | 1 | 2.7 | 2.0 | 2.0 | 2.0 | 0.7 | 8 | 2 | 4 | 2 | 0 | 0 | ** |
| A10. With Foreign Units | 3 | 2.6 | 4 | 3.0 | 3 | 3.7 | 3.0 | 2.3 | 3.1 | 0.5 | 8 | 0 | 1 | 5 | 2 | 0 | xxx |
| A11. MOUT | 2 | 1.8 | 3 | 1.0 | 1 | 2.0 | 2.0 | 2.2 | 1.9 | 0.6 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| B. LOCATION OF TRAINING | | | | | | | | | | | | | | | | | |
| B1. Theater | 4 | 2.6 | 1 | 2.0 | 2 | 3.0 | 3.0 | 2.3 | 2.5 | 0.8 | 8 | 1 | 3 | 3 | 1 | 0 | * |
| B2. Major training center | 1 | 1.3 | 1 | 1.5 | 1 | 1.3 | 1.0 | 1.2 | 1.1 | 0.2 | 8 | 8 | 0 | 0 | 0 | 0 | *** |
| B3. Smaller training cent | 1 | 1.5 | 1 | 1.5 | 1 | 1.5 | 1.5 | 2.4 | 1.4 | 0.4 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| B4. Dedicated training ce | 1 | 1.9 | 2 | 2.0 | 1 | 2.0 | 2.5 | 1.6 | 1.8 | 0.5 | 8 | 2 | 6 | 0 | 0 | 0 | ** |
| B5. Large home stations | 1 | 1.8 | 1 | 2.0 | 3 | 1.8 | 1.0 | 1.0 | 1.6 | 0.7 | 8 | 4 | 3 | 1 | 0 | 0 | ** |
| B6. Smaller home stations | 1 | 1.6 | 1 | 1.5 | 2 | 2.0 | 1.0 | 2.4 | 1.6 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 | ** |
| B7. Schools | 1 | 2.2 | 2 | 2.0 | 2 | 2.0 | 3.0 | 2.4 | 2.1 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | * |
| B8. National Guard Armory | 2 | 2.8 | 2 | 3.0 | 3 | 3.0 | 2.0 | 2.3 | 2.5 | 0.5 | 8 | 0 | 4 | 4 | 0 | 0 | |
| B9. Army reserve Training | 2 | 2.5 | 2 | 3.0 | 3 | 3.0 | 2.0 | 2.8 | 2.5 | 0.4 | 8 | 0 | 4 | 4 | 0 | 0 | |
| C. UNIT SIZE | | | | | | | | | | | | | | | | | |
| C1. Individual | 1 | 2.1 | 1 | 1.5 | 1 | 2.8 | 2.0 | 1.8 | 1.6 | 0.6 | 8 | 4 | 3 | 1 | 0 | 0 | ** |
| C2. Crew/team | 1 | 1.7 | 1 | 1.5 | 1 | 1.5 | 2.0 | 1.2 | 1.4 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| C3. Squad/Section | 1 | 1.8 | 1 | 1.0 | 1 | 1.3 | 1.5 | 1.2 | 1.2 | 0.3 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| C4. Platoon/Troop | 1 | 1.7 | 1 | 1.0 | 1 | 1.5 | 1.0 | 1.2 | 1.2 | 0.3 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| C5. Company | 1 | 1.8 | 1 | 1.0 | 1 | 1.3 | 1.0 | 1.3 | 1.2 | 0.3 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| C6. Battalion | 1 | 2.1 | 1 | 2.5 | 1 | 1.3 | 1.0 | 1.3 | 1.4 | 0.5 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| C7. Battalion Task Force | 1 | 2.5 | 1 | 3.0 | 2 | 1.5 | 1.0 | 1.0 | 1.6 | 0.7 | 8 | 5 | 2 | 1 | 0 | 0 | ** |
| C8. Regiment/Brigade | 2 | 2.8 | 2 | 3.0 | 3 | 2.0 | 2.0 | 2.0 | 2.3 | 0.4 | 8 | 0 | 5 | 3 | 0 | 0 | * |
| C9. Division | 3 | 2.9 | 3 | 4.0 | 3 | 3.0 | 3.0 | 2.0 | 3.0 | 0.5 | 8 | 0 | 1 | 6 | 1 | 0 | |
| C10.Corps/Echelons above | 3 | 3.5 | 3 | 4.0 | 2 | 3.7 | 3.0 | 2.3 | 3.1 | 0.6 | 8 | 0 | 2 | 4 | 2 | 0 | xxx |
| D. TYPE OF INSTRUMENTED PLATFORM | | | | | | | | | | | | | | | | | |
| D1. Dismounted troops | 1 | 1.4 | 1 | 1.0 | 1 | 1.7 | 1.5 | 1.8 | 1.3 | 0.3 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| D2. Crew-served ground we | 1 | 1.3 | 1 | 1.5 | 1 | 1.5 | 1.5 | 1.6 | 1.3 | 0.2 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| D3. Armored vehicle | 2 | 1.4 | 1 | 2.0 | 1 | 1.3 | 1.0 | 1.2 | 1.4 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| D4. Non-armored vehicles | 1 | 1.7 | 1 | 3.5 | 2 | 2.0 | 2.0 | 2.4 | 1.9 | 0.7 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| D5. Air defense artillery | 1 | 1.5 | 1 | 2.0 | 1 | 1.3 | 1.5 | 2.0 | 1.4 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| D6. Self-propelled howitz | 4 | 1.9 | 1 | 2.0 | 2 | 1.3 | 2.0 | 2.3 | 2.1 | 0.8 | 8 | 2 | 5 | 0 | 1 | 0 | * |

PNS QUESTIONNAIRE RESULTS FOR THE ACTIVE FIELD UNITS

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D7. Towed howitzers | 3 | 1.8 | 1 | 3.0 | 2 | 1.3 | 2.0 | 2.3 | 2.0 | 0.7 | 8 | 2 | 4 | 2 | 0 | 0 | * |
| D8. Attack helicopters | 2 | 1.5 | 1 | 1.5 | 1 | 1.0 | 1.0 | 1.4 | 1.3 | 0.3 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| D9. Scout helicopters | 2 | 1.7 | 1 | 1.5 | 1 | 1.0 | 1.0 | 1.4 | 1.3 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| D10. Transport helicopter | 2 | 1.6 | 1 | 1.5 | 1 | 1.5 | 1.0 | 1.8 | 1.4 | 0.4 | 8 | 5 | 3 | 0 | 0 | 0 | *** |
| D11. Surveillance aircraf | 2 | 2.1 | 1 | 1.5 | 2 | 3.0 | 2.0 | 1.8 | 1.9 | 0.5 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| D12. Low speed aircraft | 3 | 1.7 | 1 | 2.0 | 2 | 1.8 | 2.0 | 1.6 | 1.9 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | ** |
| D13. High speed aircraft | 3 | 1.9 | 1 | 2.5 | 2 | 1.7 | 2.0 | 1.6 | 2.0 | 0.6 | 8 | 1 | 6 | 1 | 0 | 0 | ** |
| D14. Combat service suppo | 2 | 2.1 | 1 | 2.0 | 2 | 2.3 | 1.5 | 2.2 | 1.9 | 0.4 | 8 | 2 | 6 | 0 | 0 | 0 | ** |
| D15. All platforms/vehicl | 2 | 2.4 | 1 | 2.0 | 2 | 3.0 | 2.0 | 2.4 | 2.1 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | * |
| E. TYPE OF WEAPONS | | | | | | | | | | | | | | | | | |
| E1. Pistol | 4 | 3.3 | 1 | 3.0 | 3 | 3.0 | 3.0 | 2.6 | 2.9 | 0.8 | 8 | 1 | 0 | 6 | 1 | 0 | |
| E2. Rifle | 1 | 1.3 | 1 | 1.0 | 1 | 1.0 | 1.5 | 1.6 | 1.2 | 0.2 | 8 | 7 | 1 | 0 | 0 | 0 | *** |
| E3. Machine gun | 1 | 1.4 | 1 | 1.0 | 1 | 1.0 | 1.5 | 1.4 | 1.2 | 0.2 | 8 | 8 | 0 | 0 | 0 | 0 | *** |
| E4. Hand grenade | 4 | 2.2 | 1 | 2.5 | 1 | 2.0 | 2.0 | 2.0 | 2.1 | 0.9 | 8 | 2 | 5 | 0 | 1 | 0 | * |
| E5. Grenade launcher | 1 | 1.9 | 1 | 2.0 | 1 | 1.3 | 2.0 | 1.4 | 1.5 | 0.4 | 8 | 5 | 3 | 0 | 0 | 0 | *** |
| E6. Explosive charges | 2 | 2.3 | 1 | 2.5 | 2 | 1.7 | 2.5 | 2.8 | 2.1 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | * |
| E7. Mines, conventional | 3 | 1.9 | 1 | 2.0 | 2 | 1.3 | 2.0 | 1.8 | 1.9 | 0.5 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| E8. Mines, scatterable | 3 | 2.1 | 1 | 2.0 | 1 | 1.7 | 2.0 | 2.0 | 1.8 | 0.6 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| E9. Mines Chemical | 3 | 2.3 | 1 | 2.5 | 2 | 2.0 | 2.0 | 2.0 | 2.1 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | * |
| E10. Mortar | 2 | 1.6 | 1 | 1.5 | 2 | 1.3 | 2.0 | 2.0 | 1.7 | 0.4 | 8 | 3 | 5 | 0 | 0 | 0 | ** |
| E11. Tank/fighting vehicl | 1 | 1.6 | 1 | 3.0 | 1 | 1.0 | 1.0 | 1.6 | 1.4 | 0.7 | 8 | 5 | 2 | 1 | 0 | 0 | *** |
| E12. Air defense | 2 | 1.4 | 1 | 2.0 | 1 | 1.0 | 1.5 | 1.0 | 1.4 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| E13. Antitank guided miss | 1 | 1.4 | 1 | 3.0 | 1 | 1.0 | 1.5 | 1.2 | 1.4 | 0.6 | 8 | 7 | 0 | 1 | 0 | 0 | *** |
| E14. Artillery, conventio | 2 | 1.6 | 1 | 2.0 | 1 | 1.0 | 2.0 | 1.2 | 1.5 | 0.4 | 8 | 4 | 4 | 0 | 0 | 0 | *** |
| E15. Artillery, rocket | 2 | 2.1 | 1 | 2.5 | 3 | 1.7 | 2.0 | 1.4 | 2.0 | 0.6 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| E16. Artillery, chemical | 2 | 1.9 | 1 | 3.0 | 2 | 1.7 | 2.0 | 1.8 | 1.9 | 0.5 | 8 | 1 | 6 | 1 | 0 | 0 | ** |
| E17. Aircraft bombs/clust | 3 | 2.1 | 1 | 2.5 | 2 | 1.5 | 2.0 | 1.6 | 2.0 | 0.6 | 8 | 2 | 5 | 1 | 0 | 0 | ** |
| E18. Air-to-air | 3 | 2.2 | 1 | 2.0 | 3 | 1.5 | 2.0 | 2.8 | 2.2 | 0.7 | 8 | 2 | 3 | 3 | 0 | 0 | * |
| E19. Air-to-surface | 3 | 1.8 | 1 | 2.0 | 1 | 1.0 | 2.0 | 1.8 | 1.7 | 0.6 | 8 | 3 | 4 | 1 | 0 | 0 | ** |
| E20. Directed energy | 4 | 2.5 | 1 | 2.0 | 4 | | 1.0 | 2.0 | 2.4 | 1.2 | 7 | 2 | 3 | 0 | 2 | 0 | * |
| F. SMART WEAPONS | | | | | | | | | | | | | | | | | |
| F1. Weapon assembly and s | 1 | 2.4 | 2 | 1.0 | 1 | 2.5 | | 2.0 | 1.7 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| F2. Weapon checkout | 1 | 2.6 | 2 | 1.0 | 2 | 2.3 | | 2.0 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| F3. Loading | 1 | 2.6 | 2 | 2.0 | 1 | 2.3 | | 2.0 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| F4. Target acquisition | 1 | 1.8 | 1 | 3.0 | 1 | 1.0 | | 1.5 | 1.5 | 0.7 | 7 | 5 | 1 | 1 | 0 | 0 | *** |
| F5. Aiming and tracking | 1 | 1.7 | 1 | 2.0 | 1 | 1.0 | | 1.5 | 1.3 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| F6. Firing | 1 | 1.9 | 1 | 2.0 | 1 | 1.0 | | 1.0 | 1.3 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| F7. Weapon firing signatu | 1 | 2.4 | 1 | 2.0 | 1 | 1.3 | | 1.0 | 1.4 | 0.5 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| F8. Target area effects | 1 | 1.8 | 1 | 2.0 | 1 | 1.5 | | 1.0 | 1.3 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| F9. Realtime casualty ass | 1 | 1.8 | 1 | 2.0 | 2 | 1.5 | | 1.0 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| F10. Integration of all o | 1 | 2.0 | 1 | | 1 | 1.5 | 1.0 | 2.0 | 1.4 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | *** |
| G. SIMULATED GUNNERY | | | | | | | | | | | | | | | | | |
| G1. Shoot-on-the-move | 1 | 1.8 | 1 | 1.5 | 2 | 2.3 | 2.0 | 1.0 | 1.6 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 | ** |
| G2. Shoot at moving targe | 1 | 1.2 | 1 | 1.5 | 1 | 1.8 | 2.0 | 1.0 | 1.3 | 0.4 | 8 | 6 | 2 | 0 | 0 | 0 | *** |
| G3. Target lead | 1 | 1.6 | 1 | 2.0 | 1 | 1.8 | 1.5 | 1.7 | 1.4 | 0.4 | 8 | 4 | 4 | 0 | 0 | 0 | *** |
| G4. Wind effects, ballist | 1 | 2.2 | 1 | 2.5 | 1 | 2.3 | 2.5 | 2.0 | 1.8 | 0.7 | 8 | 3 | 5 | 0 | 0 | 0 | ** |
| G5. Selection of ammuniti | 1 | 2.1 | 1 | 2.0 | 1 | 2.3 | 2.0 | 1.5 | 1.6 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 | ** |
| G6. Ranging | 1 | 1.6 | 1 | 2.0 | 1 | 1.8 | 2.0 | 1.0 | 1.4 | 0.4 | 8 | 4 | 4 | 0 | 0 | 0 | *** |
| G7. Ballistics | 1 | 2.0 | 1 | 2.0 | 2 | 2.0 | 3.0 | 1.5 | 1.8 | 0.6 | 8 | 3 | 4 | 1 | 0 | 0 | ** |
| G8. Simulation of weapon | 1 | 1.9 | 1 | 2.0 | 1 | 1.8 | 2.0 | 1.0 | 1.5 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 | *** |
| G9. Provide for the effec | 1 | 2.2 | 1 | 2.0 | 2 | 1.5 | 2.0 | 1.0 | 1.6 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 | ** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G10. Burst-on-target-cue | 1 | 2.2 | 1 | 2.0 | 1 | 2.3 | 2.0 | 1.3 | 1.6 | 0.5 | 8 | 4 | 4 | 0 | 0 | 0 ** |
| G11. Tracers | 3 | 2.2 | 1 | 3.0 | 2 | 3.0 | 3.0 | 1.5 | 2.3 | 0.7 | 8 | 2 | 2 | 4 | 0 | 0 * |
| G12. Firing cues and sign | 2 | 1.9 | 1 | 2.5 | 1 | 1.5 | 2.5 | 1.0 | 1.7 | 0.6 | 8 | 4 | 4 | 0 | 0 | 0 ** |
| G13. TES to supplement li | 1 | 1.9 | 2 | 3.5 | 2 | 2.0 | 2.0 | 2.5 | 2.1 | 0.7 | 8 | 1 | 6 | 1 | 0 | 0 * |
| G14. TES to replace live | 1 | 3.5 | 5 | 5.0 | 5 | 3.5 | 3.5 | 5.0 | 3.9 | 1.3 | 8 | 1 | 0 | 2 | 1 | 4 xxx |
| G15. Provide same system | 1 | 2.2 | 1 | 2.0 | 2 | 1.8 | 2.5 | 1.3 | 1.7 | 0.5 | 8 | 3 | 5 | 0 | 0 | 0 ** |
| G16. Simulation of recoil | 3 | 2.2 | 1 | 2.5 | 3 | 3.8 | 2.5 | 3.0 | 2.6 | 0.8 | 8 | 1 | 3 | 3 | 1 | 0 |
| G17. Simulation of loadin | 3 | 2.2 | 1 | 2.5 | 2 | 3.3 | 2.0 | 3.7 | 2.5 | 0.8 | 8 | 1 | 4 | 2 | 1 | 0 * |
| G18. Zero or boresight of | 4 | 1.8 | 2 | 2.5 | 1 | 1.5 | 2.5 | 1.7 | 2.1 | 0.8 | 8 | 2 | 5 | 0 | 1 | 0 * |
| G19. Dry-firing of weapon | 4 | 1.9 | 2 | 3.5 | 2 | 2.8 | 4.0 | 1.3 | 2.7 | 1.0 | 8 | 1 | 3 | 2 | 2 | 0 |
| G20. Real-time feedback t | 2 | 1.6 | 1 | 2.0 | 1 | 1.8 | 3.0 | 1.3 | 1.7 | 0.6 | 8 | 3 | 4 | 1 | 0 | 0 ** |
| H. EMBEDDING | | | | | | | | | | | | | | | | |
| H0. Embedding is not desi | 1 | 1.0 | | 0.0 | | 1.0 | 1.0 | 1.0 | 0.8 | 0.4 | 6 | 5 | 0 | 0 | 0 | 0 *** |
| H1. Small arms | | 2.9 | 2 | 3.0 | | 4.3 | 5.0 | 2.5 | 3.3 | 1.0 | 6 | 0 | 2 | 2 | 1 | 1 xxx |
| H2. Crew-served weapons | | 2.4 | 1 | 3.0 | | 3.3 | 4.0 | 1.0 | 2.5 | 1.1 | 6 | 2 | 1 | 2 | 1 | 0 * |
| H3. Armored vehicles | | 1.8 | 1 | 3.0 | | 2.0 | 3.0 | 2.0 | 2.1 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 * |
| H4. Non-armored vehicles | | 2.6 | 2 | 3.0 | | 3.5 | 4.0 | 2.5 | 2.9 | 0.7 | 6 | 0 | 2 | 3 | 1 | 0 |
| H5. Artillery | | 2.4 | 1 | 3.0 | | 3.0 | 4.0 | 2.0 | 2.6 | 0.9 | 6 | 1 | 2 | 2 | 1 | 0 |
| H6. Helicopters | | 1.8 | 1 | 3.0 | | 1.5 | 4.0 | 1.0 | 2.0 | 1.1 | 6 | 3 | 1 | 1 | 1 | 0 * |
| H7. Aircraft | | 2.0 | 2 | 3.0 | | 2.0 | 4.0 | 1.0 | 2.3 | 0.9 | 6 | 1 | 3 | 1 | 1 | 0 * |
| H8. Provide engagement rehearsal | | 1.9 | 2 | 3.0 | | 3.0 | 4.0 | 1.0 | 2.5 | 1.0 | 6 | 1 | 2 | 2 | 1 | 0 * |
| I. AIR DEFENSE | | | | | | | | | | | | | | | | |
| I1. Provide TES which rea | 1 | 1.4 | 1 | 2.0 | | 1.3 | 2.5 | 1.4 | 1.5 | 0.5 | 7 | 5 | 2 | 0 | 0 | 0 ** |
| I2. Provide instrumented | 2 | 1.8 | 1 | 2.0 | | 2.8 | 3.0 | 2.0 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 * |
| I3. Instrument helicopter | 1 | 1.6 | 1 | 2.0 | | 1.8 | 2.5 | 1.4 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| I4. Instrument low speed | 1 | 1.8 | 1 | 2.0 | | 2.3 | 2.5 | 1.4 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| I5. Instrument fast mover | 1 | 1.7 | 1 | 3.0 | | 2.3 | 2.5 | 1.4 | 1.8 | 0.7 | 7 | 3 | 3 | 1 | 0 | 0 ** |
| I6. Realistically simulat | 1 | 1.8 | 1 | 2.0 | | 1.3 | 2.5 | 1.4 | 1.6 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 ** |
| I7. Include capability to | 1 | 2.0 | 1 | 2.0 | | 1.5 | 2.0 | 1.4 | 1.6 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 ** |
| I8. Include IFF in all en | 2 | 2.1 | 1 | | | 1.3 | 2.0 | 2.5 | 1.8 | 0.5 | 6 | 2 | 4 | 0 | 0 | 0 ** |
| I9. In maneuver exercise, a/d should be simulated out to a range of: | | | | | | | | | | | | | | | | |
| I9. 1 km | 2 | 1.9 | 1 | 2.0 | | 2.0 | 2.0 | 3.0 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 ** |
| I9 10 km | 1 | 2.6 | 2 | 2.0 | | 2.7 | 2.0 | 2.7 | 2.1 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 * |
| I9 Maximum range of av | 1 | 1.9 | 1 | 2.0 | | 2.5 | 2.0 | 1.3 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| I10. Include the effects | 1 | 2.3 | 2 | 2.0 | | 2.3 | 2.5 | 1.4 | 1.9 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| I11. Provide realistic VI | 2 | 2.1 | 2 | 2.0 | | 2.3 | 3.0 | 2.6 | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 * |
| I12. Provide video covera | 2 | 2.3 | 2 | 2.0 | | 2.3 | 2.5 | 2.2 | 2.2 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 * |
| J. ARTILLERY & MORTARS | | | | | | | | | | | | | | | | |
| J1. Loading rounds - proc | 2 | 2.4 | 2 | 2.0 | | 3.0 | 2.0 | 2.6 | 2.3 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 * |
| J2. Loading rounds - weig | 2 | 2.4 | 1 | 2.0 | | 3.0 | 2.0 | 3.0 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 * |
| J3. Loading rounds - load | 2 | 2.5 | 2 | 2.0 | | 2.7 | 2.0 | 2.6 | 2.2 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 * |
| J4. Laying the weapon | 1 | 2.0 | 1 | 2.0 | | 2.7 | 2.0 | 1.8 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 ** |
| J5. Firing the weapon - p | 1 | 2.0 | 1 | 2.0 | | 2.3 | 2.0 | 1.8 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| J6. Firing the weapon - r | 3 | 2.7 | 1 | 2.0 | | 3.0 | 2.0 | 3.0 | 2.4 | 0.7 | 7 | 1 | 2 | 4 | 0 | 0 * |
| J7. Firing the weapon - f | 2 | 2.4 | 1 | 2.0 | | 2.0 | 2.0 | 2.4 | 2.0 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 ** |
| J8. Adjustment of fire | 1 | 1.5 | 1 | 1.0 | | 1.3 | 1.0 | 1.8 | 1.2 | 0.3 | 7 | 6 | 1 | 0 | 0 | 0 *** |
| J9. Target area cues for | 1 | 1.6 | 1 | 3.0 | | 1.3 | 1.0 | 1.4 | 1.5 | 0.7 | 7 | 5 | 1 | 1 | 0 | 0 *** |
| J10. Use of Battery Compu | 1 | 2.0 | 1 | | | 1.3 | 2.0 | 2.0 | 1.6 | 0.5 | 6 | 3 | 3 | 0 | 0 | 0 ** |
| J11. Use of TACFIRE | 1 | 2.3 | 1 | | | 1.0 | 2.0 | 2.0 | 1.6 | 0.6 | 6 | 3 | 3 | 0 | 0 | 0 ** |
| J12. Simulate/replicate e | 1 | 2.3 | 2 | 2.0 | | 1.7 | 2.0 | 2.5 | 1.9 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 ** |
| J13. Simulate loss of com | 3 | 2.7 | 2 | 3.0 | | 2.3 | 2.0 | 3.0 | 2.5 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J14. Defense of area | 3 | 1.8 | 2 | 3.0 | 2.7 | 2.0 | 2.5 | 2.4 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| J15. Counter battery fire | 2 | 1.8 | 1 | 2.0 | 1.3 | 1.0 | 1.5 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| J16. Direct fire | 1 | 1.8 | 2 | | 1.7 | 2.0 | 1.5 | 1.7 | 0.3 | 6 | 2 | 4 | 0 | 0 | 0 | ** |
| J17. Improved munitions( | 3 | 2.1 | 1 | | 2.3 | 2.0 | 1.5 | 2.0 | 0.6 | 6 | 2 | 3 | 1 | 0 | 0 | ** |
| J18. Selection, use, cons | 1 | 1.8 | 2 | 2.0 | 3.0 | 1.0 | 2.0 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| K. ARTILLERY & MORTAR EFFECTS | | | | | | | | | | | | | | | | |
| K1. Flash of incoming rou | 1 | 2.2 | 2 | 2.5 | 1.0 | 3.0 | 2.2 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| K2. Bang of incoming roun | 1 | 2.0 | 2 | 2.5 | 2.0 | 3.0 | 2.0 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| K3. Smoke of incoming rou | 1 | 2.2 | 2 | 2.5 | 1.3 | 3.0 | 2.2 | 2.0 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | * |
| K4. Simulated ground burs | 1 | 1.8 | 2 | 2.0 | 1.0 | 1.0 | 2.6 | 1.6 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| K5. Simulated air burst | 1 | 2.2 | 2 | 2.0 | 1.0 | 3.0 | 2.6 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | ** |
| K6. Attrition of vehicles | 1 | 1.9 | 1 | 2.5 | 1.0 | 2.0 | 1.5 | 1.6 | 0.6 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| K7. Attrition of vehicle | 1 | 1.7 | 1 | 2.5 | 1.0 | 2.0 | 1.5 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| K8. Attrition of dismount | 1 | 1.6 | 1 | 2.5 | 1.0 | 2.0 | 1.5 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| K9. Suppression | 3 | 1.7 | 2 | 2.0 | 1.3 | 3.0 | 1.8 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| K10. Simulation of damage | 3 | 2.5 | 2 | 3.0 | 2.0 | 4.0 | 2.5 | 2.7 | 0.6 | 7 | 0 | 3 | 3 | 1 | 0 | |
| K11. Simulation of damage | 3 | 2.4 | 2 | 3.0 | 1.7 | 3.0 | 2.3 | 2.5 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | * |
| K12. Real-time casualty a | 1 | 1.6 | 1 | 2.5 | 1.3 | 3.0 | 2.0 | 1.8 | 0.7 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| K13. Adjustment of fire | 1 | 1.5 | 1 | 2.5 | 1.0 | 3.0 | 1.7 | 1.7 | 0.7 | 7 | 4 | 2 | 1 | 0 | 0 | ** |
| K14. Round-for-round-simu | 2 | 1.9 | 2 | 2.0 | 1.3 | 4.0 | 1.5 | 2.1 | 0.8 | 7 | 2 | 4 | 0 | 1 | 0 | * |
| K15. Surprise | 1 | 1.8 | 2 | 2.5 | 2.0 | | 1.8 | 1.8 | 0.4 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| K16. Time fidelity for re | 1 | 1.9 | 2 | 2.5 | 1.7 | 3.0 | 1.8 | 2.0 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| L. MINES | | | | | | | | | | | | | | | | |
| L1. Replicate the size of | 2 | 2.0 | 1 | 2.5 | 3.3 | 3.0 | 2.0 | 2.3 | 0.7 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| L2. Replicate the weight | 2 | 2.0 | 1 | 2.5 | 3.3 | 3.0 | 1.8 | 2.2 | 0.7 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| L3. Replicate the trip me | 1 | 1.7 | 1 | 2.0 | 3.3 | 3.0 | 1.6 | 2.0 | 0.8 | 7 | 2 | 3 | 2 | 0 | 0 | ** |
| L4. Reproduce detection c | 1 | 1.9 | 1 | 2.0 | 2.0 | 2.5 | 1.6 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| L5. Simulate mines on a o | 2 | 2.2 | 2 | 2.5 | 2.7 | 3.0 | 2.2 | 2.4 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L6. Simulate mines on a g | 2 | 2.6 | 2 | 2.0 | 1.7 | 3.0 | 2.2 | 2.2 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| L7. Simulate the attritio | 3 | 1.8 | 2 | 2.0 | 1.7 | 2.5 | 1.5 | 2.1 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| L8. Simulate only the ove | 1 | 2.6 | 2 | 2.0 | 2.7 | 2.0 | 2.8 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| 19. Provide for simulatin | 1 | 2.0 | 2 | 3.0 | 3.0 | 2.5 | 2.2 | 2.2 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| L10. Provide for simulati | 1 | 1.8 | 1 | 3.0 | 2.0 | 2.0 | 1.6 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| L11. Provide for simulati | 1 | 2.0 | 1 | 3.0 | 2.3 | 2.0 | 1.6 | 1.8 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| L12. Provide for simulati | 1 | 2.1 | 1 | 3.0 | 2.7 | 2.0 | 1.6 | 1.9 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | ** |
| L13. Provide for simulati | 1 | 1.9 | 1 | 2.0 | 1.7 | 2.0 | 1.8 | 1.6 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| L14. Provide for simulati | 1 | 2.3 | 2 | 3.0 | 2.3 | 2.5 | 2.0 | 2.2 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| L15. Provide real-time ca | 1 | 1.6 | 1 | 2.0 | 1.7 | 2.5 | 1.5 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| L16. Provides real-time c | 1 | 1.6 | 1 | 2.0 | 1.7 | 2.5 | 1.5 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| L17. Attrition of any pla | 2 | 1.9 | 1 | 2.0 | 2.7 | 2.5 | 1.5 | 1.9 | 0.5 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| L18. Attrition of only ma | 1 | 3.1 | 1 | 3.0 | 2.7 | 2.5 | 2.0 | 2.2 | 0.8 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| L19. Mine reuse after usi | 1 | 2.3 | 2 | 3.0 | 2.3 | 2.5 | 1.6 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| L20. Threat mine warfare | 1 | 1.7 | 1 | 2.0 | 1.7 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| M. NUCLEAR/BIOLOGICAL/CHEMICAL | | | | | | | | | | | | | | | | |
| M1. Training intended for | 1 | 2.6 | 1 | 2.0 | 3.3 | 2.5 | 2.4 | 2.1 | 0.8 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| M2. Training intended for | 1 | 1.6 | 1 | 2.0 | 2.0 | 2.5 | 2.4 | 1.8 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| M3. NBC training exercise | 3 | 3.6 | 1 | 5.0 | 3.5 | 3.5 | 3.5 | 3.3 | 1.1 | 7 | 1 | 0 | 4 | 1 | 1 | xxx |
| M4. Integrated N<B< and C | 2 | 2.0 | 1 | 1.0 | 1.8 | 1.5 | 2.0 | 1.6 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| M5. Use of notional units | 2 | 3.1 | 2 | 3.0 | 2.8 | 3.5 | 2.8 | 2.7 | 0.5 | 7 | 0 | 2 | 5 | 0 | 0 | |
| M6. Different NBC simulan | 2 | 2.1 | 1 | 2.0 | 2.3 | 2.5 | 1.8 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| M7. Use NBC warning and r | 1 | 1.9 | 1 | 2.0 | 1.8 | 2.5 | 1.6 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M8. NBC monitoring and su | 1 | 1.9 | 1 | 2.0 | 1.8 | 2.5 | 1.8 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| M9. NBC simulation devic | 1 | 2.2 | 1 | 2.0 | 2.0 | 2.5 | 2.0 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| M10. NBC Simulation train | 1 | 2.2 | 1 | 2.0 | 2.0 | 3.0 | 2.3 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| M11. Flash/bang/smoke cues for nu | | 2.2 | 2 | 2.0 | 2.3 | 3.0 | 2.2 | 2.3 | 0.3 | 6 | 0 | 5 | 1 | 0 | 0 | * |
| M12. Traveling through a simulate | | 1.9 | 2 | 2.0 | 1.5 | 2.5 | 2.2 | 2.0 | 0.3 | 6 | 1 | 5 | 0 | 0 | 0 | * |
| M13. Nuclear training should be provided for unit size of: | | | | | | | | | | | | | | | | |
| M13. Squad | | 1.9 | 1 | 1.0 | 2.7 | 3.5 | 1.5 | 1.9 | 0.9 | 6 | 3 | 1 | 2 | 0 | 0 | ** |
| M13. Platoon | | 2.1 | 1 | 1.0 | 2.3 | 3.5 | 1.5 | 1.9 | 0.9 | 6 | 3 | 2 | 1 | 0 | 0 | ** |
| M13. Company | | 1.8 | 1 | 1.0 | 2.0 | 3.5 | 1.3 | 1.8 | 0.9 | 6 | 3 | 2 | 1 | 0 | 0 | ** |
| M13. Battalion/task force | | 2.1 | 1 | 2.0 | 2.0 | 3.5 | 1.2 | 2.0 | 0.8 | 6 | 2 | 3 | 1 | 0 | 0 | ** |
| M13 Larger than battalion | | 2.8 | 2 | 3.0 | 2.3 | 2.0 | 2.0 | 2.3 | 0.4 | 6 | 0 | 4 | 2 | 0 | 0 | * |
| M14. Nuclear simulation should provide for: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| M14. Total dose | | 2.6 | | 2.0 | 2.5 | 2.5 | 1.8 | 2.3 | 0.3 | 5 | 0 | 4 | 1 | 0 | 0 | * |
| M14. Dose rate | | 2.5 | | 2.0 | 2.3 | 2.5 | 1.6 | 2.2 | 0.3 | 5 | 0 | 5 | 0 | 0 | 0 | * |
| M14. Dose rate and total dose | | 2.4 | 1 | 1.0 | 2.5 | 2.5 | 1.0 | 1.7 | 0.7 | 6 | 3 | 3 | 0 | 0 | 0 | ** |
| M14 Armor protection | | 2.8 | 1 | 2.0 | 1.8 | 3.0 | 1.0 | 1.9 | 0.8 | 6 | 2 | 2 | 2 | 0 | 0 | ** |
| M14 EMP/TREE simulation | | 2.6 | | 2.0 | 1.8 | 2.0 | 1.3 | 1.9 | 0.4 | 5 | 1 | 3 | 1 | 0 | 0 | ** |
| M15. Simulation of biological tox | | 2.7 | 1 | 3.0 | 2.3 | 3.5 | 2.4 | 2.5 | 0.8 | 6 | 1 | 2 | 3 | 0 | 0 | * |
| M16. Simulation of biological org | | 2.8 | 2 | 3.0 | 2.5 | 3.5 | 2.4 | 2.7 | 0.5 | 6 | 0 | 3 | 3 | 0 | 0 | |
| M17. Simulation of contamination transfer: | | | | | | | | | | | | | | | | |
| M17 To interiors of armored veh | | 2.6 | 1 | 3.0 | 2.0 | 3.5 | 2.2 | 2.4 | 0.8 | 6 | 1 | 2 | 3 | 0 | 0 | * |
| M17 From one area to another | | 2.5 | 1 | 3.0 | 2.3 | 3.0 | 2.2 | 2.3 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| M18. Provide surprise delivery to | | 2.1 | 2 | 3.0 | 2.3 | 3.0 | 2.2 | 2.4 | 0.4 | 6 | 0 | 4 | 2 | 0 | 0 | * |
| M19. Provide surprise CS and CSS | | 2.3 | 2 | 3.0 | 2.3 | 3.0 | 2.2 | 2.5 | 0.4 | 6 | 0 | 4 | 2 | 0 | 0 | * |
| M20. Persistent simulant decontam | | 2.2 | 1 | 2.5 | 1.8 | 2.5 | 2.0 | 2.0 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| M21. Simulation of nonpersistent | | 2.0 | 1 | 2.5 | 2.0 | 2.0 | 2.0 | 1.9 | 0.4 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| M22. Simulation of persistent che | | 2.3 | 1 | 2.5 | 1.8 | 2.5 | 2.0 | 2.0 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| M23. Delivery of chemical agents | | 2.6 | 2 | 3.0 | 2.0 | 2.5 | 2.2 | 2.4 | 0.4 | 6 | 0 | 4 | 2 | 0 | 0 | * |
| M24. Delivery of chemical agents | | 2.3 | 2 | 2.5 | 1.8 | 2.0 | 2.0 | 2.1 | 0.2 | 6 | 0 | 6 | 0 | 0 | 0 | * |
| M25. Real-time casualty assessmen | | 1.8 | 1 | 2.5 | 1.8 | 3.0 | 1.8 | 2.0 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | ** |
| M26. Training in all MOPP levels | | 1.6 | 1 | 1.5 | 1.5 | 2.5 | 1.8 | 1.7 | 0.4 | 6 | 3 | 3 | 0 | 0 | 0 | ** |
| N. MOUT | | | | | | | | | | | | | | | | |
| N1. Indication of simulated damag | | 2.4 | 1 | 2.5 | 2.3 | 1.5 | 2.8 | 2.1 | 0.6 | 6 | 2 | 3 | 1 | 0 | 0 | * |
| N2. Simulate the protecti | 2 | 2.2 | 1 | 2.0 | 1.7 | 2.0 | 2.2 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 | ** |
| N3. Simulate protection degradati | | 2.5 | 1 | 2.5 | 2.3 | 2.0 | 2.0 | 2.1 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | * |
| N4. Casualties on personnel insid | | 2.2 | 1 | 2.5 | 1.7 | 2.0 | 1.8 | 1.9 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| N5. Simulate TES weapons inside o | | 2.1 | 1 | 2.5 | 1.7 | 2.0 | 1.8 | 1.8 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| N6. Engage at night | | 1.8 | 1 | 1.5 | 1.3 | 2.0 | 1.4 | 1.5 | 0.3 | 6 | 4 | 2 | 0 | 0 | 0 | ** |
| N7. Engage through obscurants | | 2.1 | 1 | 2.0 | 1.7 | 2.0 | 1.4 | 1.7 | 0.4 | 6 | 2 | 4 | 0 | 0 | 0 | ** |
| N8. Engage at very close range | | 2.0 | 1 | 2.0 | 1.7 | 2.0 | 1.6 | 1.7 | 0.4 | 6 | 1 | 5 | 0 | 0 | 0 | ** |
| N9. Simulate attrition from use o | | 2.1 | 1 | 2.5 | 2.0 | 2.5 | 2.4 | 2.1 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | * |
| N10. Emphasize the instrumentatio | | 2.0 | 1 | 2.0 | 2.0 | 3.0 | 2.2 | 2.0 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| N11. Cues in MOUT: | | | | | | | | | | | | | | | | |
| N11. Weapon firing | 1 | 1.6 | 1 | 1.0 | 1.7 | 2.0 | 1.8 | 1.4 | 0.4 | 7 | 3 | 4 | 0 | 0 | 0 | *** |
| N11. Noise | 1 | 2.1 | 1 | 1.5 | 2.0 | 2.0 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| N11. Flash | 1 | 1.9 | 1 | 2.0 | 2.3 | 2.0 | 2.0 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| N11. Smoke | 1 | 1.9 | 1 | 2.0 | 2.3 | 3.0 | 2.0 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| N11. Pellets, dye or | 1 | 2.6 | 1 | 2.5 | 2.0 | 2.0 | 2.2 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| N11. Hit signatures | 1 | 2.1 | 1 | 2.0 | 2.0 | 3.5 | 2.0 | 1.9 | 0.8 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| N11. Smoke from burni | 1 | 2.4 | 1 | 3.0 | 2.0 | 3.0 | 2.0 | 2.1 | 0.8 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| O. COMMAND AND CONTROL | | | | | | | | | | | | | | | | |

PNS QUESTIONNAIRE RESULTS FOR THE ACTIVE FIELD UNITS

TES PMS QUESTIONNAIRE RESULTS FIELD UNIT RESULTS NOV. 6, 1987

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O1. Instrument command an | 1 | 2.1 | 1 | 2.0 | 1.3 | 2.0 | 1.8 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| O2. Simulate command and | 1 | 2.2 | 2 | 3.0 | 2.0 | 3.5 | 2.5 | 2.3 | 0.7 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| O3. Provide command and c | 1 | 2.4 | 2 | 2.5 | 2.5 | 3.5 | 2.0 | 2.3 | 0.7 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| O4. Simulate tactical com | 1 | 2.5 | 1 | 2.5 | 1.5 | 3.0 | 3.0 | 2.1 | 0.8 | 7 | 3 | 1 | 3 | 0 | 0 | * |
| O5. Simulate or provide a | 1 | 2.2 | 1 | 2.0 | 1.3 | 2.5 | 2.0 | 1.7 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| O6. Provide TES data or v | 1 | 2.2 | 1 | 1.5 | 1.8 | 2.0 | 2.3 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| O7. Provide TES communica | 1 | 2.2 | 2 | 1.5 | 1.8 | 2.0 | 2.3 | 1.8 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| P. COMBAT SUPPORT | | | | | | | | | | | | | | | | |
| P1. Instrument combat sup | 3 | 2.9 | | 4.0 | 2.8 | 3.0 | 2.4 | 3.0 | 0.5 | 6 | 0 | 1 | 4 | 1 | 0 | xxx |
| P2. Instrument combat sup | 3 | 3.0 | | 4.0 | 3.3 | 3.0 | 2.4 | 3.1 | 0.5 | 6 | 0 | 1 | 4 | 1 | 0 | xxx |
| P3. Instrument all potent | 3 | 2.2 | 1 | 2.0 | 2.3 | 2.0 | 1.6 | 2.0 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| P4. Simulate combat suppo | 3 | 2.6 | 1 | 3.0 | 2.8 | 3.0 | 2.2 | 2.5 | 0.7 | 7 | 1 | 1 | 5 | 0 | 0 | |
| P5. Provide logistics rea | 3 | 1.8 | 1 | 2.0 | 1.8 | 1.5 | 1.2 | 1.7 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| P6. Provide for field med | 3 | 2.1 | 1 | 2.0 | 2.0 | 2.0 | 1.6 | 2.0 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| P7. Provide for problems | 3 | 1.9 | 1 | 2.0 | 1.7 | 2.0 | 1.8 | 1.9 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | ** |
| P8. Provide for problems | 3 | 1.8 | 1 | 2.0 | 1.8 | 2.0 | 1.4 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| P9. Provide for problems | 3 | 1.9 | 2 | 2.5 | 1.8 | 2.0 | 1.6 | 2.1 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 | * |
| Q. COMMUNICATION DISRUPTION | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| Q1. Provide for the simul | 3 | 1.9 | 1 | 1.5 | 1.5 | 2.5 | 2.4 | 2.0 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| Q2. Provide for the actua | 3 | 2.5 | | 1.5 | 2.0 | 2.5 | 2.8 | 2.4 | 0.5 | 6 | 1 | 2 | 3 | 0 | 0 | * |
| Q3. Use actual RF jamming | 3 | 1.8 | 1 | 3.0 | 1.5 | 2.5 | 2.2 | 2.1 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| Q4. Disrupt communication | 3 | 2.0 | 1 | 1.5 | 2.0 | 3.0 | 3.3 | 2.3 | 0.8 | 7 | 2 | 2 | 3 | 0 | 0 | * |
| Q5. Disrupt only selected | 3 | 2.9 | 1 | 3.5 | 1.8 | 3.0 | 3.0 | 2.6 | 0.8 | 7 | 1 | 1 | 5 | 0 | 0 | |
| Q6. Automatically attrit | 3 | 2.9 | 1 | 2.0 | 1.3 | 3.0 | 2.8 | 2.3 | 0.8 | 7 | 2 | 1 | 4 | 0 | 0 | * |
| Q7. Penalize excessive tr | 3 | 2.5 | 1 | 2.5 | 2.3 | 3.0 | 1.4 | 2.2 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| Q8. Simulate communicatio | 3 | 2.3 | 1 | 2.0 | 2.0 | 2.5 | 2.4 | 2.2 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Q9. Allow simulated repai | 3 | 2.2 | 2 | 2.0 | 2.5 | 3.0 | 2.3 | 2.4 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| Q10. Provide for antenna | 3 | 2.5 | 1 | 2.0 | 3.0 | 2.0 | 2.5 | 2.3 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| Q11. Simulate EMI on electronic s | | 2.5 | 1 | 2.0 | 2.0 | 2.5 | 2.4 | 2.1 | 0.5 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| Q12. Simulate EMI on computers or | | 2.5 | 1 | 2.0 | 2.5 | 2.5 | 2.4 | 2.2 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 | * |
| R. OPFOR | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| R0. OPFOR is not necessary | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| R1. Threat maneuver tacti | 1 | 1.4 | 1 | 1.5 | 1.3 | 1.5 | 1.0 | 1.2 | 0.2 | 7 | 7 | 0 | 0 | 0 | 0 | *** |
| R2. Actual OPFOR vehicles | 1 | 2.1 | 1 | 2.0 | 2.0 | 3.0 | 2.5 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| R3. VISMODS for OPFOR veh | 1 | 1.9 | 1 | 1.5 | 1.5 | 2.0 | 1.5 | 1.5 | 0.4 | 7 | 5 | 2 | 0 | 0 | 0 | ** |
| R4. Actual threat weapons | 1 | 2.1 | 1 | 2.0 | 2.3 | 3.0 | 2.5 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| R5. Threat weapons charac | 1 | 2.4 | 1 | 1.5 | 2.3 | 1.5 | 1.3 | 1.6 | 0.5 | 7 | 5 | 2 | 0 | 0 | 0 | ** |
| R6. Threat weapon performance: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| R6. Available capabili | 1 | 2.0 | 1 | 2.0 | 1.5 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| R6. Latest (classified | 1 | 2.1 | 2 | 2.5 | 3.0 | 2.0 | 1.3 | 2.0 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| R7. Simulation of threat target vulnerability: | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| R7. Available ( unclas | 1 | 2.1 | 1 | 2.0 | 1.5 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| R7. Latest (classified | 1 | 2.1 | 2 | 2.5 | 2.8 | 2.0 | 1.3 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| R8. Threat uniforms | 1 | 1.7 | 1 | 2.0 | 2.0 | 3.0 | 2.3 | 1.8 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| S. OBSCURATION | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| S1. Shoot through obscura | 1 | 1.9 | 1 | 1.5 | 2.7 | 2.5 | 1.8 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| S2. Sight through obscura | 1 | 1.8 | 1 | 2.0 | 2.0 | 2.5 | 1.8 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| S3. Shoot through soft co | 1 | 1.9 | 1 | 2.0 | 2.3 | 3.0 | 2.0 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| S4. Provide IR-opaque tra | 1 | 2.5 | 1 | 2.0 | 2.0 | 3.5 | 2.2 | 2.0 | 0.8 | 7 | 2 | 4 | 1 | 0 | 0 | * |
| S5. Simulate only the eff | 1 | 3.0 | 2 | 2.0 | 3.0 | 3.0 | 3.2 | 2.5 | 0.8 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| S6. Simulate delivery of | 1 | 2.6 | 2 | 2.5 | 2.0 | 3.0 | 2.6 | 2.2 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |

PMS QUESTIONNAIRE RESULTS FOR THE ACTIVE FIELD UNITS

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S7. Simulate delivery of | 1 | 2.9 | 2 | 2.0 | 2.0 | 3.0 | 2.8 | 2.2 | 0.7 | 7 | 1 | 3 | 3 | 0 | 0 * |
| T. SIGNATURES | | | | | | | | | | | | | | | |
| T1. Hit flash | 1 | 1.9 | 1 | 1.5 | 1.8 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| T2. Kill smoke | 1 | 1.9 | 1 | 1.5 | 1.5 | 2.0 | 1.8 | 1.5 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 ** |
| T3. Weapon flash | 1 | 2.2 | 1 | 2.5 | 2.3 | 3.0 | 1.8 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 ** |
| T4. Weapon smoke | 1 | 2.6 | 1 | 2.5 | 2.0 | 3.0 | 2.2 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 * |
| T5. Weapon bang | 1 | 1.9 | 1 | 2.0 | 2.3 | 2.5 | 1.8 | 1.8 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T6. Tracers | 1 | 2.4 | 1 | 2.0 | 2.3 | 2.5 | 2.2 | 1.9 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T7. Burst on target | 1 | 2.0 | 1 | 2.0 | 2.5 | 2.5 | 2.4 | 1.9 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T8. Incoming artillery or | 1 | 2.6 | 1 | 2.5 | 3.0 | 3.5 | 2.6 | 2.3 | 0.9 | 7 | 2 | 1 | 4 | 0 | 0 * |
| T9. Incoming artillery or | 1 | 2.5 | 1 | 2.5 | 1.8 | 2.5 | 2.6 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 ** |
| T10. Incoming artillery o | 1 | 2.1 | 1 | 2.5 | 1.7 | 2.5 | 2.0 | 1.8 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T11. Mine flash | 1 | 1.9 | 1 | 2.0 | 1.3 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| T12. Mine bang | 1 | 2.0 | 1 | 2.0 | 1.7 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T13. Mine smoke | 1 | 2.4 | 1 | 2.0 | 2.7 | 2.5 | 2.0 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 ** |
| T14. Different signatures | 1 | 2.3 | 1 | 2.5 | 2.3 | 2.5 | 2.0 | 1.9 | 0.6 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T15. Different signatures | 1 | 2.4 | 1 | 2.5 | 2.3 | 3.0 | 2.0 | 2.0 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 * |
| T16. Signatures as cues f | 1 | 2.4 | 1 | 2.0 | 1.8 | 2.0 | 2.0 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| T17. Signatures as cues f | 1 | 2.9 | 1 | 2.0 | 1.8 | 2.5 | 2.4 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 ** |
| T18. Signatures through sight ima | | 2.2 | 1 | 2.0 | 1.5 | 3.0 | 2.4 | 2.0 | 0.6 | 6 | 2 | 3 | 1 | 0 | 0 * |
| U. ATTRITION | | | | | | | | | | | | | | | |
| U1. Multiple levels of hi | 1 | 2.0 | 2 | 2.5 | 1.8 | 2.0 | 1.4 | 1.8 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| U2. Higher probability of | 1 | 1.9 | 1 | 2.0 | 1.8 | 2.0 | 1.6 | 1.6 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| U3. Hit quadrant on a veh | 1 | 2.2 | 2 | 2.5 | 2.3 | 2.5 | 1.6 | 2.0 | 0.5 | 7 | 1 | 6 | 0 | 0 | 0 ** |
| U4. The effect on the pro | 2 | 2.6 | 2 | 2.0 | 2.8 | 2.5 | 2.0 | 2.3 | 0.3 | 7 | 0 | 5 | 2 | 0 | 0 * |
| U5. Multiple levels on in | 2 | 2.7 | 2 | 2.0 | 3.0 | 3.0 | 2.2 | 2.4 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 * |
| U6. Head shot on individu | 2 | 2.4 | 2 | 2.0 | 2.3 | 2.5 | 2.0 | 2.2 | 0.2 | 7 | 0 | 7 | 0 | 0 | 0 * |
| U7. Indication of who sho | 2 | 2.4 | 2 | 2.0 | 1.8 | 3.0 | 2.2 | 2.2 | 0.4 | 7 | 0 | 6 | 1 | 0 | 0 * |
| U8. Distinguish/identify | 2 | 1.8 | 1 | 2.0 | 1.5 | 2.5 | 1.8 | 1.8 | 0.4 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| V. CASUALTY ASSESSMENT | | | | | | | | | | | | | | | |
| V1. For vehicles, loss of | 1 | 1.6 | 1 | 2.0 | 2.3 | 2.5 | 1.4 | 1.7 | 0.6 | 7 | 3 | 4 | 0 | 0 | 0 ** |
| V2. Loss of radio | 1 | 1.8 | 1 | 2.0 | 1.8 | 2.5 | 2.0 | 1.7 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 ** |
| V3. Attrition of individu | 2 | 1.7 | 1 | 2.0 | 2.3 | 2.5 | 1.8 | 1.9 | 0.4 | 7 | 1 | 6 | 0 | 0 | 0 ** |
| V4. Casualty assessed aut | 1 | 2.1 | 1 | 1.5 | 2.8 | 2.5 | 1.6 | 1.8 | 0.6 | 7 | 3 | 3 | 1 | 0 | 0 ** |
| V5. Indication for the me | 2 | 2.0 | 1 | 2.0 | 2.8 | 2.5 | 1.8 | 2.0 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 ** |
| V6. Elimination of contro | 2 | 2.8 | 2 | 3.5 | 2.5 | 2.5 | 2.4 | 2.5 | 0.5 | 7 | 0 | 5 | 2 | 0 | 0 |
| W. INTEROPERABILITY | | | | | | | | | | | | | | | |
| W1. MILES | | 1.4 | 1 | 1.5 | 1.0 | 1.0 | 1.4 | 1.2 | 0.2 | 6 | 6 | 0 | 0 | 0 | 0 *** |
| W2. UCOFT, or similar crew traine | | 2.0 | 1 | 1.0 | 2.0 | 2.0 | 3.0 | 1.8 | 0.7 | 6 | 2 | 3 | 1 | 0 | 0 ** |
| W3. TWGSS, or similar gunnery tra | | 1.7 | 1 | | 2.0 | 2.5 | 3.0 | 2.0 | 0.7 | 5 | 1 | 3 | 1 | 0 | 0 * |
| W4. ARTBASS, or other staff train | | 2.4 | 1 | | 2.0 | 2.5 | 2.7 | 2.1 | 0.6 | 5 | 1 | 3 | 1 | 0 | 0 * |
| W5. Test instrumentation such as | | 2.2 | 3 | | 2.0 | 2.5 | 1.0 | 2.1 | 0.7 | 5 | 1 | 3 | 1 | 0 | 0 * |
| W6. Other NATO TES systems such a | | 2.0 | 3 | | 2.0 | 3.0 | 2.3 | 2.5 | 0.5 | 5 | 0 | 3 | 2 | 0 | 0 * |
| W7. Future new equipment capabili | | 2.0 | 1 | 2.0 | 1.3 | 2.5 | 1.8 | 1.8 | 0.5 | 6 | 2 | 4 | 0 | 0 | 0 ** |
| W8. Future improvements to curren | | 2.0 | 1 | 2.0 | 1.8 | 2.5 | 1.8 | 1.8 | 0.4 | 6 | 1 | 5 | 0 | 0 | 0 ** |
| W9. Future threat equipment and c | | 1.9 | 1 | 2.0 | 1.8 | 2.5 | 2.3 | 1.9 | 0.5 | 6 | 1 | 5 | 0 | 0 | 0 ** |
| X. CHEATING | | | | | | | | | | | | | | | |
| X0. Cheating is not important in design of future TES system | | | | | | | | | | | | | | | |
| X1. System should be as c | 1 | 1.6 | 1 | 1.0 | 2.0 | 1.5 | 1.7 | 1.4 | 0.4 | 7 | 4 | 3 | 0 | 0 | 0 *** |
| X2. TES systems should di | 1 | 2.0 | 1 | 1.5 | 3.3 | 2.5 | 1.7 | 1.8 | 0.8 | 7 | 3 | 3 | 1 | 0 | 0 ** |
| X3. Use of MILES-type keys should | | 2.4 | 3 | 1.5 | 3.5 | 2.5 | 2.0 | 2.5 | 0.6 | 6 | 1 | 3 | 2 | 0 | 0 * |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X4. Equipment should be made more | | 1.8 | 3 | 1.0 | 2.3 | 3.0 | 1.7 | 2.1 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| X5. The number of soldier-operate | | 2.1 | 1 | 2.0 | 2.8 | 2.5 | 2.0 | 2.1 | 0.5 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| X6. More functions should be dele | | 3.2 | 5 | 3.0 | 4.0 | 3.0 | 2.3 | 3.4 | 0.9 | 6 | 0 | 1 | 3 | 1 | 1 | xxx |
| Y. CONTROLLERS | | | | | | | | | | | | | | | | |
| Y1. Control the flow of t | 2 | 2.6 | 1 | 1.5 | 2.8 | 2.5 | 1.4 | 2.0 | 0.6 | 7 | 3 | 2 | 2 | 0 | 0 | ** |
| Y2. Arbitrate problems an | 2 | 1.8 | 1 | 3.5 | 2.0 | 2.5 | 1.8 | 2.1 | 0.7 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Y3. Evaluate trainees | 2 | 2.2 | 1 | 2.5 | 2.0 | 2.5 | 2.8 | 2.1 | 0.5 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Y4. Assess casualties | 2 | 2.1 | 5 | 2.5 | 2.0 | 2.5 | 2.6 | 2.7 | 1.0 | 7 | 0 | 5 | 1 | 0 | 1 | |
| Y5. Prevent cheating | 2 | 2.1 | 1 | 2.0 | 2.0 | 3.0 | 2.4 | 2.1 | 0.6 | 7 | 1 | 5 | 1 | 0 | 0 | * |
| Y6. Emphasis should be pl | 2 | 2.0 | 1 | 3.0 | 2.3 | 2.0 | 1.0 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| Y7. More use should be ma | 2 | 2.8 | 3 | 3.5 | 3.0 | 4.0 | 4.2 | 3.2 | 0.7 | 7 | 0 | 1 | 4 | 2 | 0 | xxx |
| Y8. TES systems should be | 2 | 2.1 | 1 | 3.0 | 2.0 | 2.5 | 1.0 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| Z. POSITION LOCATION | | | | | | | | | | | | | | | | |
| Z1. Location of every pla | 2 | 2.6 | 1 | 2.5 | 3.3 | 4.0 | 3.0 | 2.6 | 0.9 | 7 | 1 | 2 | 3 | 1 | 0 | |
| Z2. Location of major wea | 2 | 1.9 | 1 | 2.5 | 1.3 | 1.5 | 2.0 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| Z3. Location of all but d | 2 | 2.6 | 5 | 2.0 | 2.5 | 2.5 | 2.8 | 2.8 | 1.0 | 7 | 0 | 4 | 2 | 0 | 1 | |
| Z4. Location to within 10 | 2 | 2.4 | 5 | 1.5 | 2.8 | 2.5 | 2.0 | 2.6 | 1.1 | 7 | 1 | 4 | 1 | 0 | 1 | |
| Z5. Location to within 10 meters | | 2.3 | 1 | 2.5 | 2.3 | 3.0 | 2.8 | 2.3 | 0.6 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| Z6. Location to within 1 meter | | 3.5 | 3 | 3.5 | 3.3 | 4.0 | 3.2 | 3.4 | 0.3 | 6 | 0 | 0 | 5 | 1 | 0 | xxx |
| Z7. Include altitude as well as X | | 2.2 | 3 | 2.5 | 2.8 | 3.0 | 2.8 | 2.7 | 0.3 | 6 | 0 | 2 | 4 | 0 | 0 | |
| Z8. Include orientation of vehicl | | 2.6 | 1 | 2.5 | 3.3 | 3.0 | 2.0 | 2.4 | 0.7 | 6 | 1 | 2 | 3 | 0 | 0 | * |
| Z9. Include orientation of weapon | | 2.1 | 1 | 2.5 | 3.0 | 2.5 | 2.0 | 2.2 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| Z0. Location continuously updated | | 2.0 | 3 | 3.0 | 2.0 | 3.0 | 2.0 | 2.5 | 0.5 | 6 | 0 | 3 | 3 | 0 | 0 | * |
| Z1. Location needed only when eng | | 3.4 | 1 | 1.5 | 2.0 | 2.5 | 2.3 | 2.1 | 0.7 | 6 | 2 | 3 | 1 | 0 | 0 | * |
| AA. INTERVISIBILITY | | | | | | | | | | | | | | | | |
| AA0. Intervisibility not importan | | 1.0 | | 1.0 | | | | 1.0 | 0.0 | 2 | 2 | 0 | 0 | 0 | 0 | *** |
| AA1. Include intervisibil | 1 | 2.2 | 1 | 2.0 | 2.0 | 3.0 | 2.3 | 1.9 | 0.7 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| AA2. Include intervisibil | 1 | 2.1 | 1 | 2.0 | 2.0 | 2.5 | 1.5 | 1.7 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| AA3. Provide intervisibil | 1 | 2.8 | 1 | 1.0 | 1.5 | 2.5 | 2.8 | 1.8 | 0.8 | 7 | 4 | 1 | 2 | 0 | 0 | ** |
| BB. DATA COLLECTION | | | | | | | | | | | | | | | | |
| BB1. Simplify field equipment by | | 2.2 | 3 | 2.5 | 2.8 | 2.5 | 2.5 | 2.6 | 0.3 | 6 | 0 | 4 | 2 | 0 | 0 | |
| BB2. Provide for on-board storage | | 2.1 | 1 | 2.0 | 2.8 | 3.0 | 1.8 | 2.1 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| BB3. Provide for real-time displa | | 1.9 | 1 | 2.5 | 2.0 | 3.0 | 2.0 | 2.1 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| BB4. Provide video taping of over | | 2.2 | 3 | 2.5 | 1.8 | 3.0 | 3.0 | 2.6 | 0.5 | 6 | 0 | 3 | 3 | 0 | 0 | |
| BB5. Provide video taping of sigh | | 2.8 | 1 | 2.0 | 2.3 | 2.5 | 3.0 | 2.3 | 0.6 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| BB6. Provide computer graphics fo | | 2.2 | 1 | 2.5 | 2.0 | 3.0 | 2.4 | 2.2 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| BB7. Include player position loca | | 1.9 | 1 | 2.5 | 2.5 | 3.0 | 1.6 | 2.1 | 0.7 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| BB8. Include firing weapon ID in | | 2.3 | 1 | 2.0 | 2.0 | 3.0 | 1.8 | 2.0 | 0.6 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| CC. SIZE | | | | | | | | | | | | | | | | |
| CC1. Future TES should be | 1 | 1.9 | 1 | 1.5 | 2.3 | 3.5 | 2.2 | 1.9 | 0.8 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| CC2. Size is more importa | 2 | 3.5 | 5 | 4.0 | 3.5 | 4.5 | 3.5 | 3.7 | 0.9 | 7 | 0 | 1 | 3 | 2 | 1 | xxx |
| CC3. Reduce size to impro | 2 | 2.4 | 1 | 1.5 | 2.3 | 2.5 | 2.5 | 2.0 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | * |
| CC4. Eliminate helmet det | 2 | 3.4 | 1 | 4.0 | 3.0 | 3.5 | 3.0 | 2.8 | 0.9 | 7 | 1 | 1 | 4 | 1 | 0 | |
| DD. WEIGHT | | | | | | | | | | | | | | | | |
| DD1. The maximum wt. for TES equipment carried by infantry must be: | | | | | | | | | | | | | | | | |
| DD1. Less than 2 pound | 1 | 2.1 | 1 | 2.5 | 2.0 | 3.0 | 2.7 | 2.0 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| DD1. Less than 10 pounds | | 2.2 | | 1.5 | 3.0 | 1.0 | 1.6 | 1.9 | 0.7 | 5 | 2 | 2 | 1 | 0 | 0 | ** |
| DD1. Less than 20 pounds | | 3.8 | | 2.5 | 3.0 | 3.0 | 1.5 | 2.8 | 0.7 | 5 | 1 | 1 | 2 | 1 | 0 | |
| DD2. The maximum weight for TES equipment on an helicopter must be: | | | | | | | | | | | | | | | | |
| DD2. Less than 50 pounds | | 2.4 | 1 | 2.0 | 2.3 | 3.0 | 1.0 | 2.0 | 0.7 | 6 | 2 | 3 | 1 | 0 | 0 | ** |
| DD2. Less than 200 pounds | | 2.7 | | 4.0 | 1.7 | 3.0 | 2.0 | 2.7 | 0.8 | 5 | 0 | 2 | 2 | 1 | 0 | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DD3. The maximum weight for TES equipment on a fixed-wing a/c must be: | | | | | | | | | | | | | | | | |
| DD3. less than 50 pounds | | 2.8 | 1 | 2.0 | 2.5 | 3.0 | 1.0 | 2.0 | 0.8 | 6 | 2 | 2 | 2 | 0 | 0 | * |
| DD3. less than 200 pounds | | 2.0 | | 4.0 | 1.0 | 2.0 | 1.5 | 2.1 | 1.0 | 5 | 2 | 2 | 0 | 1 | 0 | * |
| EE. TYPE OF ELECTRICAL POWER | | | | | | | | | | | | | | | | |
| EE1. Use of vehicle power | 2 | 2.2 | 1 | 2.0 | 2.8 | 2.0 | 1.0 | 1.9 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| EE2. Use of special high | 2 | 3.7 | 1 | 4.0 | 3.3 | 3.5 | 3.8 | 3.0 | 1.0 | 7 | 1 | 1 | 2 | 3 | 0 | xxx |
| EE3. Use standard commerc | 2 | 2.3 | 3 | 2.5 | 3.0 | 3.0 | 2.0 | 2.5 | 0.4 | 7 | 0 | 4 | 3 | 0 | 0 | |
| EE4. Use rechargeable bat | 2 | 2.6 | 1 | 2.0 | 2.3 | 3.0 | 2.2 | 2.1 | 0.6 | 7 | 1 | 4 | 2 | 0 | 0 | * |
| EE5. Minimize use of batteries | | 2.2 | 1 | 2.5 | 2.7 | 2.0 | 1.8 | 2.0 | 0.5 | 6 | 1 | 4 | 1 | 0 | 0 | * |
| EE6. Use size and quantity of bat | | 1.8 | 1 | 2.0 | 3.3 | 3.0 | 1.8 | 2.2 | 0.8 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| FF. BUILT-IN TEST (BITE) | | | | | | | | | | | | | | | | |
| FF0. BITE is not important to fut | | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 5 | 5 | 0 | 0 | 0 | 0 | *** |
| FF1. BITE operable by use | 1 | 1.7 | 1 | 1.0 | 3.3 | 3.0 | 1.7 | 1.8 | 0.9 | 7 | 3 | 2 | 2 | 0 | 0 | ** |
| FF2. BITE operable by rep | 1 | 3.7 | 1 | 5.0 | 2.3 | 2.0 | 3.0 | 2.6 | 1.3 | 7 | 2 | 2 | 1 | 1 | 1 | |
| FF3. Activates automatica | 1 | 2.4 | 1 | 2.0 | 2.7 | 3.0 | 2.3 | 2.1 | 0.7 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| FF4. System-level BITE (G | 1 | 2.7 | 2 | 5.0 | 1.7 | 3.0 | 2.0 | 2.5 | 1.2 | 7 | 1 | 3 | 2 | 0 | 1 | * |
| FF5. System-level BITE (w | 1 | 1.9 | 1 | 1.0 | 2.3 | 3.0 | 2.0 | 1.7 | 0.7 | 7 | 3 | 3 | 1 | 0 | 0 | ** |
| FF6. Component level BITE | 1 | 2.8 | | 1.0 | 2.3 | 2.0 | 2.0 | 1.9 | 0.7 | 6 | 2 | 3 | 1 | 0 | 0 | ** |
| GG. INSTALLATION | | | | | | | | | | | | | | | | |
| GG1. More permanent installation | | 2.9 | 1 | 4.0 | 3.0 | 3.0 | 1.8 | 2.6 | 1.0 | 6 | 1 | 1 | 3 | 1 | 0 | |
| GG2. Much easier to insta | 1 | 1.9 | 1 | 2.0 | 2.0 | 3.0 | 1.8 | 1.8 | 0.6 | 7 | 2 | 4 | 1 | 0 | 0 | ** |
| GG3. Installation at a tES instal | | 3.8 | | 4.0 | 3.8 | 3.0 | 3.8 | 3.7 | 0.3 | 5 | 0 | 0 | 1 | 4 | 0 | xxx |
| GG4. Installation anywher | 1 | 1.7 | 1 | 1.5 | 1.8 | 2.5 | 1.0 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| GG5. Installation by civilian per | | 4.2 | | 4.0 | 2.8 | 3.5 | 4.2 | 3.7 | 0.5 | 5 | 0 | 0 | 2 | 3 | 0 | xxx |
| GG6. Installation by mili | 1 | 1.7 | 1 | 4.0 | 1.5 | 2.0 | 1.0 | 1.7 | 1.0 | 7 | 4 | 2 | 0 | 1 | 0 | ** |
| GG7. Installation by specialists | | 3.9 | | 4.0 | 3.3 | 4.0 | 4.4 | 3.9 | 0.4 | 5 | 0 | 0 | 1 | 4 | 0 | xxx |
| HH. ISSUE | | | | | | | | | | | | | | | | |
| HH1. At least some components of | | 4.1 | 1 | 3.0 | 4.5 | 4.0 | 2.8 | 3.2 | 1.2 | 6 | 1 | 0 | 2 | 3 | 0 | xxx |
| HH2. Future TES should be | 1 | 2.0 | 1 | 1.5 | 2.5 | 1.5 | 1.5 | 1.6 | 0.5 | 7 | 5 | 2 | 0 | 0 | 0 | ** |
| HH3. Future TES should be issued | | 2.7 | 5 | 2.0 | 2.0 | 3.0 | 2.8 | 2.9 | 1.0 | 6 | 0 | 2 | 3 | 0 | 1 | |
| HH4. TES equipment issued should | | 2.5 | 2 | 3.0 | 1.3 | 3.0 | 2.4 | 2.4 | 0.6 | 6 | 1 | 2 | 3 | 0 | 0 | * |
| HH5. Emphasis should be placed on | | 3.2 | 1 | 4.0 | 3.8 | 3.5 | 2.6 | 3.0 | 1.0 | 6 | 1 | 0 | 3 | 2 | 0 | xxx |
| HH6. TES equipment sets should in | | 1.6 | 1 | 1.0 | 1.8 | 2.5 | 1.6 | 1.6 | 0.5 | 6 | 2 | 4 | 0 | 0 | 0 | ** |
| HH7. Each battalion shoul | 1 | 1.9 | 1 | 1.0 | 2.3 | 2.0 | 1.4 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| II. MAINTENANCE | | | | | | | | | | | | | | | | |
| II1. TES components desig | 1 | 1.4 | 1 | 2.0 | 2.5 | 2.0 | 1.6 | 1.6 | 0.5 | 7 | 3 | 4 | 0 | 0 | 0 | ** |
| II2. TES sys. designed for easy fault isolation: | | | | | | | | | | | | | | | | |
| II2. By troops | 1 | 2.4 | 1 | 2.5 | 3.0 | 3.0 | 1.4 | 2.0 | 0.8 | 7 | 3 | 2 | 2 | 0 | 0 | * |
| II2. By TASC | 1 | 2.3 | | 2.0 | 2.3 | 3.0 | 3.0 | 2.3 | 0.7 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| II2. By CLS only | | 4.2 | | 4.5 | 3.5 | 3.0 | 3.3 | 3.7 | 0.6 | 5 | 0 | 0 | 3 | 2 | 0 | xxx |
| II3. Component replacement in the | | 1.8 | 1 | 1.5 | 2.0 | 3.0 | 1.6 | 1.8 | 0.6 | 6 | 2 | 3 | 1 | 0 | 0 | ** |
| II4. Component replacement by TAS | | 2.2 | | 2.0 | 1.8 | 2.5 | 2.6 | 2.2 | 0.3 | 5 | 0 | 4 | 1 | 0 | 0 | * |
| II5. Component repair by TASC | | 2.1 | | 2.0 | 2.0 | 2.5 | 1.8 | 2.1 | 0.2 | 5 | 0 | 5 | 0 | 0 | 0 | * |
| II6. Repair by military personnel | | 2.0 | 1 | 2.0 | 2.0 | 3.0 | 2.7 | 2.1 | 0.6 | 6 | 1 | 3 | 2 | 0 | 0 | * |
| II7. Repair by civilian personnel | | 3.4 | | 3.5 | 1.8 | 3.0 | 2.7 | 2.9 | 0.6 | 5 | 0 | 1 | 4 | 0 | 0 | |
| JJ. TES EQUIPMENT TRAINING | | | | | | | | | | | | | | | | |
| JJ1. Introduction to TES | 3 | 2.4 | 3 | 1.5 | 2.3 | 1.5 | 2.2 | 2.3 | 0.6 | 7 | 2 | 3 | 2 | 0 | 0 | * |
| JJ2. Expand TES training | 3 | 2.5 | 3 | 1.5 | 2.0 | 2.5 | 2.2 | 2.4 | 0.5 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| JJ3. Expand TES training | 3 | 2.6 | 2 | 1.5 | 2.8 | 2.5 | 2.2 | 2.4 | 0.5 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| JJ4. Provide more trainin | 3 | 2.5 | 3 | 1.5 | 2.3 | 3.5 | 2.0 | 2.5 | 0.6 | 7 | 1 | 2 | 4 | 0 | 0 | |
| JJ5. Provide more trainin | 3 | 2.4 | 3 | 2.0 | 2.5 | 3.5 | 2.0 | 2.6 | 0.5 | 7 | 0 | 4 | 3 | 0 | 0 | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JJ6. Provide videotapes f | 3 | 2.6 | 3 | 1.5 | 2.0 | 2.0 | 1.8 | 2.3 | 0.6 | 7 | 1 | 3 | 3 | 0 | 0 | * |
| JJ7. Provide simulators o | 3 | 2.3 | 2 | 1.5 | 2.8 | 3.0 | 2.6 | 2.5 | 0.5 | 7 | 1 | 2 | 4 | 0 | 0 | * |
| JJ8. Provide training aid | 3 | 2.3 | 2 | 2.0 | 2.5 | 3.0 | 2.2 | 2.4 | 0.4 | 7 | 0 | 5 | 2 | 0 | 0 | * |
| KK. TARGETS | | | | | | | | | | | | | | | | |
| KK1. Cues to indicate hit | 1 | 1.7 | 1 | 2.0 | 1.3 | 2.5 | 1.0 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | *** |
| KK2. Hit sensors on targe | 1 | 1.7 | 1 | 2.0 | 1.3 | 2.5 | 1.0 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| KK3. Targets with shootba | 1 | 2.1 | 1 | 1.5 | 2.3 | 2.5 | 1.3 | 1.7 | 0.6 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| KK4. Real-time casualty a | 1 | 1.8 | 1 | 2.0 | 1.5 | 2.5 | 1.0 | 1.5 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| KK5. Probability of kill adjusted | | 1.9 | 1 | 1.5 | 1.8 | 2.5 | 1.3 | 1.6 | 0.5 | 6 | 3 | 3 | 0 | 0 | 0 | ** |
| KK6. Wpn and target pairi | 1 | 2.4 | 2 | 2.5 | 1.5 | 2.5 | 1.8 | 2.0 | 0.5 | 7 | 2 | 5 | 0 | 0 | 0 | ** |
| KK7. Wpn and target pairi | 1 | 2.3 | 2 | 1.5 | 1.3 | 2.5 | 1.3 | 1.7 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| KK8. Wpn and target pairi | 1 | 2.1 | 2 | 1.5 | 1.5 | 2.5 | 1.5 | 1.7 | 0.5 | 7 | 4 | 3 | 0 | 0 | 0 | ** |
| | 39 | | 59 | | | | | AVERAGE | STAND | NO. | | | | | | |

TFS PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

RESULTS OF PNS QUESTIONNAIRE FOR TFS
06-Nov-87
RESULTS FOR THE RESERVE COMPONENTS AND NATIONAL GUARDS

A = 0.50 to 1.51
B = 1.51 to 2.50
C = 2.51 to 3.50
D = 3.51 to 4.50
F = 4.51 to 5.00

| All questionnaires from one organization were averaged and put into one column. Each column was weighted equally. So each organization has one equal vote. | RESERVES | | | | | | | | | GRADE DISTRIBUTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6TH ARMY 66 | 5TH ARMY 67 | 4th Army AVER 68-71 | 2ND ARMY 72 | 1ST ARMY AVER 73-122 | NAT GUARD BUR 5 | AVERAGE | STAND DEV | NO. REPLIES | A | B | C | D | F | |
| A. TYPE OF TRAINING | | | | | | | | | | | | | | | |
| A1. Maneuver | 1 | 2 | 1.0 | 1 | 1.5 | 1 | 1.3 | 0.3 | 23 | 5 | 1 | 0 | 0 | 0 | *** |
| A2. Gunnery | 2 | 2 | 1.3 | 2 | 1.7 | 1 | 1.5 | 0.6 | 23 | 2 | 4 | 0 | 0 | 0 | ** |
| A3. Command/leader | 3 | 3 | 2.0 | 3 | 2.2 | 1 | 2.1 | 0.6 | 23 | 1 | 2 | 3 | 0 | 0 | * |
| A4. Command and Control Staff | 3 | 2 | 2.5 | 3 | 2.3 | 3 | 2.3 | 0.4 | 23 | 0 | 3 | 3 | 0 | 0 | * |
| A5. Crew Skills | 2 | 2 | 1.5 | 2 | 1.8 | 4 | 1.9 | 0.6 | 23 | 1 | 4 | 0 | 1 | 0 | ** |
| A6. Technical Skills | 3 | 3 | 2.5 | 2 | 2.3 | 4 | 2.4 | 0.5 | 23 | 0 | 3 | 2 | 1 | 0 | * |
| A7. Combat Support | 1 | 2 | 2.0 | 3 | 2.5 | 2 | 2.3 | 0.6 | 23 | 1 | 3 | 2 | 0 | 0 | * |
| A8. Combat service support | 2 | 2 | 2.5 | 3 | 2.9 | 2 | 2.6 | 0.5 | 23 | 0 | 4 | 2 | 0 | 0 | |
| A9. Multi-Echelon | 3 | 3 | 1.5 | 2 | 2.3 | 1 | 2.1 | 0.7 | 23 | 2 | 2 | 2 | 0 | 0 | * |
| A10. With Foreign Units | 4 | | 3.0 | 2 | 3.3 | 3 | 2.9 | 0.6 | 21 | 0 | 1 | 3 | 1 | 0 | |
| A11. MOUT | 4 | 3 | 2.3 | 1 | 2.4 | 2 | 2.2 | 0.8 | 23 | 1 | 3 | 1 | 1 | 0 | * |
| B. LOCATION OF TRAINING | | | | | | | | | | | | | | | |
| B1. Theater | 1 | | 2.0 | 1 | 3.1 | 2 | 2.3 | 1.0 | 22 | 2 | 2 | 1 | 0 | 0 | * |
| B2. Major training centers | 1 | | 1.0 | 3 | 2.1 | 1 | 1.3 | 0.5 | 22 | 3 | 1 | 1 | 0 | 0 | *** |
| B3. Smaller training centers | 2 | 2 | 1.0 | 3 | 2.1 | 1 | 1.5 | 0.5 | 23 | 2 | 3 | 1 | 0 | 0 | ** |
| B4. Dedicated training centers | 2 | | 1.0 | 3 | 2.5 | 1 | 1.9 | 0.7 | 22 | 2 | 2 | 1 | 0 | 0 | ** |
| B5. Large home stations | 1 | 2 | 1.0 | 1 | 2.0 | 1 | 1.5 | 0.5 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| B6. Smaller home stations | 1 | 2 | 1.0 | 1 | 1.9 | 1 | 1.5 | 0.5 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| B7. Schools | 2 | | 2.0 | 3 | 1.9 | 2 | 2.1 | 0.5 | 22 | 0 | 4 | 1 | 0 | 0 | * |
| B8. National Guard Armory | 3 | 1 | 1.3 | 2 | 1.7 | 1 | 2.1 | 0.7 | 23 | 3 | 2 | 1 | 0 | 0 | * |
| B9. Army reserve Training Cent | 3 | 1 | 1.5 | 2 | 2.0 | 1 | 2.1 | 0.7 | 22 | 3 | 2 | 1 | 0 | 0 | * |
| C. UNIT SIZE | | | | | | | | | | | | | | | |
| C1. Individual | 1 | 2 | 1.0 | 1 | 1.7 | 2 | 1.8 | 0.6 | 23 | 3 | 3 | 0 | 0 | 0 | ** |
| C2. Crew/team | 1 | 2 | 1.3 | 1 | 1.6 | 2 | 1.6 | 0.5 | 23 | 3 | 3 | 0 | 0 | 0 | ** |
| C3. Squad/Section | 1 | 2 | 1.5 | 1 | 1.5 | 2 | 1.4 | 0.4 | 23 | 3 | 3 | 0 | 0 | 0 | *** |
| C4. Platoon/Troop | 1 | 2 | 1.8 | 1 | 1.6 | 1 | 1.4 | 0.4 | 23 | 3 | 3 | 0 | 0 | 0 | *** |
| C5. Company | 2 | 2 | 1.8 | 1 | 1.6 | 1 | 1.4 | 0.4 | 23 | 2 | 4 | 0 | 0 | 0 | *** |
| C6. Battalion | 2 | 3 | 2.0 | 2 | 1.9 | 2 | 1.7 | 0.5 | 23 | 0 | 5 | 1 | 0 | 0 | ** |
| C7. Battalion Task Force | 2 | 3 | 2.0 | 2 | 2.3 | 1 | 1.8 | 0.6 | 23 | 1 | 4 | 1 | 0 | 0 | ** |
| C8. Regiment/Brigade | 3 | 3 | 2.3 | 3 | 2.9 | 3 | 2.5 | 0.5 | 23 | 0 | 1 | 5 | 0 | 0 | * |
| C9. Division | 3 | 3 | 3.7 | 3 | 3.2 | 3 | 3.0 | 0.6 | 23 | 0 | 0 | 5 | 1 | 0 | xxx |
| C10. Corps/Echelons above Corps | 3 | 3 | 4.0 | 2 | 3.8 | 3 | 3.1 | 0.7 | 23 | 0 | 1 | 3 | 2 | 0 | xxx |
| D. TYPE OF INSTRUMENTED PLATFORM | | | | | | | | | | | | | | | |
| D1. Dismounted troops | 3 | 2 | 1.0 | 1 | 1.6 | 1 | 1.5 | 0.7 | 23 | 3 | 2 | 1 | 0 | 0 | *** |
| D2. Crew-served ground weapons | 1 | 2 | 1.0 | 1 | 1.6 | 1 | 1.4 | 0.6 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| D3. Armored vehicle | 1 | 2 | 1.0 | 1 | 1.7 | 1 | 1.3 | 0.4 | 22 | 4 | 2 | 0 | 0 | 0 | *** |
| D4. Non-armored vehicles | 1 | 2 | 1.8 | 3 | 2.2 | 2 | 1.9 | 0.6 | 23 | 1 | 4 | 1 | 0 | 0 | ** |
| D5. Air defense artillery | 2 | 2 | 2.3 | 2 | 2.6 | 1 | 1.6 | 0.5 | 23 | 1 | 4 | 1 | 0 | 0 | ** |
| D6. Self-propelled howitzers | 2 | 2 | 2.0 | 2 | 2.6 | 1 | 1.9 | 0.6 | 23 | 1 | 4 | 1 | 0 | 0 | ** |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D7. Towed howitzers | 2 | 2 | 2.5 | 1 | 2.8 | 1 | 1.9 | 0.6 | 23 | 2 | 3 | 1 | 0 | 0 | ** |
| D8. Attack helicopters | 1 | 2 | 1.5 | 2 | 2.4 | 1 | 1.4 | 0.4 | 23 | 3 | 3 | 0 | 0 | 0 | *** |
| D9. Scout helicopters | 1 | 2 | 1.3 | 2 | 2.4 | 2 | 1.5 | 0.5 | 23 | 2 | 4 | 0 | 0 | 0 | ** |
| D10. Transport helicopters | 1 | 2 | 1.5 | 2 | 2.9 | 3 | 1.9 | 0.8 | 23 | 2 | 2 | 2 | 0 | 0 | ** |
| D11. Surveillance aircraft | 1 | 3 | 1.3 | 2 | 2.9 | 1 | 2.0 | 0.7 | 23 | 3 | 1 | 2 | 0 | 0 | * |
| D12. Low speed aircraft | 1 | 2 | 1.3 | 2 | 2.7 | 2 | 1.9 | 0.5 | 23 | 2 | 3 | 1 | 0 | 0 | ** |
| D13. High speed aircraft | 1 | 3 | 1.3 | 3 | 2.8 | 2 | 2.0 | 0.7 | 23 | 2 | 1 | 3 | 0 | 0 | * |
| D14. Combat service support ve | 3 | 2 | 2.0 | 2 | 2.7 | 3 | 2.2 | 0.6 | 23 | 0 | 3 | 3 | 0 | 0 | * |
| D15. All platforms/vehicles on | 3 | 3 | 1.8 | 2 | 2.9 | 2 | 2.2 | 0.6 | 22 | 0 | 3 | 3 | 0 | 0 | * |
| E. TYPE OF WEAPONS | | | | | | | | | | | | | | | |
| E1. Pistol | 1 | 2 | 3.0 | 3 | 2.7 | 3 | 2.8 | 0.8 | 23 | 1 | 1 | 4 | 0 | 0 | |
| E2. Rifle | 1 | 2 | 1.0 | 1 | 1.5 | 1 | 1.4 | 0.5 | 23 | 5 | 1 | 0 | 0 | 0 | *** |
| E3. Machine gun | 1 | 2 | 1.0 | 1 | 1.4 | 1 | 1.4 | 0.5 | 23 | 5 | 1 | 0 | 0 | 0 | *** |
| E4. Hand grenade | 3 | 3 | 2.3 | 4 | 2.6 | 2 | 2.5 | 0.8 | 23 | 0 | 2 | 3 | 1 | 0 | * |
| E5. Grenade launcher | 3 | 2 | 2.0 | 3 | 2.0 | 1 | 2.0 | 0.6 | 23 | 1 | 3 | 2 | 0 | 0 | ** |
| E6. Explosive charges | 3 | 3 | 2.3 | 4 | 2.7 | 2 | 2.5 | 0.6 | 23 | 0 | 2 | 3 | 1 | 0 | * |
| E7. Mines, conventional | 3 | 3 | 2.0 | 2 | 2.4 | 1 | 2.1 | 0.7 | 23 | 1 | 3 | 2 | 0 | 0 | * |
| E8. Mines, scatterable | 3 | 3 | 2.3 | 2 | 2.5 | 1 | 2.1 | 0.7 | 23 | 1 | 3 | 2 | 0 | 0 | * |
| E9. Mines Chemical | 3 | 3 | 2.3 | 3 | 2.6 | 1 | 2.3 | 0.7 | 23 | 1 | 1 | 4 | 0 | 0 | * |
| E10. Mortar | 2 | 3 | 2.5 | 4 | 1.9 | 1 | 2.0 | 0.7 | 23 | 1 | 3 | 1 | 1 | 0 | * |
| E11. Tank/fighting vehicle wea | 1 | 2 | 1.5 | 1 | 1.7 | 1 | 1.4 | 0.6 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| E12. Air defense | 2 | 2 | 2.0 | 1 | 2.4 | 1 | 1.6 | 0.5 | 23 | 2 | 4 | 0 | 0 | 0 | ** |
| E13. Antitank guided missiles | 1 | 3 | 1.8 | 1 | 1.6 | 1 | 1.5 | 0.7 | 23 | 3 | 2 | 1 | 0 | 0 | ** |
| E14. Artillery, conventional | 3 | 3 | 2.5 | 2 | 2.4 | 1 | 1.7 | 0.6 | 23 | 1 | 3 | 2 | 0 | 0 | ** |
| E15. Artillery, rocket | 3 | 4 | 2.7 | 2 | 2.6 | 1 | 2.1 | 0.7 | 23 | 1 | 1 | 3 | 1 | 0 | * |
| E16. Artillery, chemical | 3 | 4 | 2.7 | 2 | 2.7 | 1 | 2.1 | 0.7 | 23 | 1 | 1 | 3 | 1 | 0 | * |
| E17. Aircraft bombs/cluster bo | 3 | 4 | 2.7 | 2 | 2.9 | 1 | 2.3 | 0.8 | 23 | 1 | 1 | 3 | 1 | 0 | * |
| E18. Air-to-air | 4 | 4 | 3.0 | 2 | 2.9 | 2 | 2.5 | 0.9 | 23 | 0 | 2 | 2 | 2 | 0 | * |
| E19. Air-to-surface | 4 | 4 | 2.7 | 2 | 2.6 | 1 | 2.1 | 1.0 | 23 | 1 | 1 | 2 | 2 | 0 | * |
| E20. Directed energy | 4 | | 1.0 | 2 | 3.1 | 1 | 2.3 | 1.0 | 21 | 2 | 1 | 1 | 1 | 0 | * |
| F. SMART WEAPONS | | | | | | | | | | | | | | | |
| F1. Weapon assembly and setup | 3 | | 3.0 | 4 | 2.5 | | 2.6 | 0.9 | 19 | 0 | 1 | 2 | 1 | 0 | |
| F2. Weapon checkout | 3 | | 3.0 | 3 | 2.4 | | 2.5 | 0.7 | 19 | 0 | 1 | 3 | 0 | 0 | |
| F3. Loading | 3 | | 3.0 | 2 | 2.3 | | 2.4 | 0.6 | 19 | 0 | 1 | 3 | 0 | 0 | * |
| F4. Target acquisition | 2 | | 1.5 | 1 | 2.2 | 1 | 1.6 | 0.5 | 20 | 3 | 2 | 0 | 0 | 0 | ** |
| F5. Aiming and tracking | 2 | | 1.5 | 1 | 2.2 | 1 | 1.5 | 0.4 | 20 | 3 | 2 | 0 | 0 | 0 | *** |
| F6. Firing | 1 | | 1.5 | 2 | 2.3 | 1 | 1.4 | 0.5 | 21 | 3 | 2 | 0 | 0 | 0 | *** |
| F7. Weapon firing signatures | 2 | | 2.3 | 3 | 2.4 | 2 | 1.9 | 0.6 | 21 | 0 | 4 | 1 | 0 | 0 | ** |
| F8. Target area effects | 3 | | 2.0 | 3 | 2.3 | 1 | 1.8 | 0.8 | 21 | 1 | 2 | 2 | 0 | 0 | ** |
| F9. Realtime casualty assessme | 1 | | 1.7 | 3 | 2.5 | 1 | 1.6 | 0.7 | 21 | 2 | 2 | 1 | 0 | 0 | ** |
| F10. Integration of all of the | 3 | | 1.5 | | 2.3 | 1 | 1.8 | 0.7 | 20 | 2 | 1 | 1 | 0 | 0 | ** |
| G. SIMULATED GUNNERY | | | | | | | | | | | | | | | |
| G1. Shoot-on-the-move | 1 | 2 | 1.0 | 1 | 1.7 | 1 | 1.5 | 0.5 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| G2. Shoot at moving targets | 1 | 2 | 1.0 | 1 | 1.6 | 1 | 1.4 | 0.4 | 23 | 4 | 2 | 0 | 0 | 0 | *** |
| G3. Target lead | 1 | 2 | 1.7 | 1 | 1.7 | 1 | 1.5 | 0.5 | 23 | 3 | 3 | 0 | 0 | 0 | ** |
| G4. Wind effects, ballistics | 1 | 2 | 2.3 | 3 | 2.5 | 1 | 2.0 | 0.7 | 23 | 2 | 3 | 1 | 0 | 0 | * |
| G5. Selection of ammunition | 2 | 2 | 1.3 | 4 | 2.2 | 1 | 1.8 | 0.7 | 23 | 2 | 3 | 0 | 1 | 0 | ** |
| G6. Ranging | 2 | 2 | 1.3 | 2 | 2.0 | 1 | 1.6 | 0.5 | 23 | 2 | 4 | 0 | 0 | 0 | ** |
| G7. Ballistics | 2 | 2 | 1.7 | 3 | 2.2 | 2 | 1.9 | 0.6 | 23 | 0 | 5 | 1 | 0 | 0 | ** |
| G8. Simulation of weapon hold- | 1 | 3 | 1.0 | 1 | 1.9 | 1 | 1.6 | 0.6 | 23 | 4 | 1 | 1 | 0 | 0 | ** |
| G9. Provide for the effects of | 2 | 2 | 2.0 | 3 | 2.0 | 2 | 1.9 | 0.6 | 23 | 0 | 5 | 1 | 0 | 0 | ** |
| G10. Burst-on-target-cue | 1 | 2 | 1.7 | 2 | 2.1 | 3 | 1.8 | 0.5 | 23 | 1 | 4 | 1 | 0 | 0 | ** |
| G11. Tracers | 2 | 2 | 2.0 | 3 | 2.3 | 3 | 2.3 | 0.8 | 23 | 0 | 4 | 2 | 0 | 0 | * |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G12. Firing cues and signature | 2 | 3 | 1.3 | 3 | 2.1 | 2 | 2.0 | 0.7 | 23 | 1 | 3 | 2 | 0 | 0 | ** |
| G13. TES to supplement live fi | 2 | 2 | 1.7 | 2 | 2.0 | 1 | 2.0 | 0.6 | 23 | 1 | 5 | 0 | 0 | 0 | ** |
| G14. TES to replace live fire | 3 | 5 | 4.0 | 2 | 3.2 | 1 | 3.5 | 1.3 | 23 | 1 | 1 | 2 | 1 | 1 | xxx |
| G15. Provide same system opera | 3 | 2 | 1.5 | 3 | 2.3 | 1 | 1.9 | 0.7 | 23 | 2 | 2 | 2 | 0 | 0 | ** |
| G16. Simulation of recoil | 1 | 2 | 1.7 | 3 | 2.4 | 2 | 2.4 | 0.8 | 23 | 1 | 4 | 1 | 0 | 0 | * |
| G17. Simulation of loading rou | 1 | 2 | 1.3 | 3 | 2.0 | 2 | 2.2 | 0.8 | 23 | 2 | 3 | 1 | 0 | 0 | * |
| G18. Zero or boresight of weap | 1 | 3 | 1.3 | 1 | 1.9 | 1 | 1.9 | 0.8 | 23 | 4 | 1 | 1 | 0 | 0 | ** |
| G19. Dry-firing of weapon | 2 | 3 | 1.7 | 1 | 2.1 | 3 | 2.5 | 0.8 | 23 | 1 | 3 | 2 | 0 | 0 | |
| G20. Real-time feedback to gun | 1 | 2 | 1.0 | 1 | 1.9 | 1 | 1.6 | 0.7 | 23 | 4 | 2 | 0 | 0 | 0 | ** |
| H. EMBEDDING | | | | | | | | | | | | | | | |
| H0. Embedding is not desirable | 1 | 1 | | | 1.0 | 1 | 1.0 | 0.4 | 15 | 4 | 0 | 0 | 0 | 0 | *** |
| H1. Small arms | | | 1.3 | 4 | 2.5 | | 3.0 | 1.2 | 16 | 1 | 1 | 0 | 1 | 0 | xxx |
| H2. Crew-served weapons | | | 1.3 | 3 | 2.3 | | 2.5 | 1.1 | 18 | 1 | 1 | 1 | 0 | 0 | * |
| H3. Armored vehicles | | | 1.7 | 1 | 1.9 | | 2.1 | 0.9 | 16 | 1 | 2 | 0 | 0 | 0 | * |
| H4. Non-armored vehicles | | | 1.7 | 3 | 2.7 | | 2.7 | 0.8 | 17 | 0 | 1 | 2 | 0 | 0 | |
| H5. Artillery | | | 2.3 | 2 | 2.5 | | 2.4 | 0.8 | 17 | 0 | 2 | 1 | 0 | 0 | * |
| H6. Helicopters | | | 1.7 | 1 | 2.1 | | 2.0 | 1.0 | 18 | 1 | 2 | 0 | 0 | 0 | * |
| H7. Aircraft | | | 2.0 | 1 | 2.1 | | 2.1 | 1.0 | 18 | 1 | 2 | 0 | 0 | 0 | * |
| H8. Provide engagement rehearsal capability in | | | 2.0 | 1 | 2.0 | | 2.3 | 1.1 | 18 | 1 | 2 | 0 | 0 | 0 | * |
| I. AIR DEFENSE | | | | | | | | | | | | | | | |
| I1. Provide TES which realisti | 1 | 2 | 1.0 | 1 | 2.4 | 1 | 1.6 | 0.6 | 22 | 4 | 2 | 0 | 0 | 0 | ** |
| I2. Provide instrumented RPVs | 2 | 3 | 2.0 | 2 | 2.6 | 1 | 2.2 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| I3. Instrument helicopters for | 2 | 3 | 1.5 | 2 | 2.7 | 2 | 1.9 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | ** |
| I4. Instrument low speed a/c f | 2 | 2 | 1.5 | 2 | 2.6 | 2 | 1.9 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| I5. Instrument fast movers for | 2 | 2 | 1.5 | 3 | 2.8 | 3 | 2.2 | 0.7 | 22 | 1 | 2 | 3 | 0 | 0 | * |
| I6. Realistically simulate a/d | 2 | 3 | 1.0 | 1 | 2.9 | 1 | 1.8 | 0.7 | 22 | 3 | 1 | 2 | 0 | 0 | ** |
| I7. Include capability to simu | 2 | 3 | 1.0 | 1 | 2.5 | 1 | 1.7 | 0.6 | 22 | 3 | 2 | 1 | 0 | 0 | ** |
| I8. Include IFF in all engagem | 2 | 3 | 2.0 | 2 | 2.6 | 1 | 1.9 | 0.7 | 21 | 1 | 3 | 2 | 0 | 0 | ** |
| I9. In maneuver exercise, a/d should be simulated out to a range of: | | | | | | | | | | | | | | | |
| I9. 1 km | | 2 | 3.0 | | 2.4 | | 2.2 | 0.7 | 19 | 0 | 2 | 1 | 0 | 0 | * |
| I9 10 km | | 3 | 2.0 | | 2.7 | | 2.3 | 0.6 | 19 | 0 | 1 | 2 | 0 | 0 | * |
| I9 Maximum range of availab | 1 | 2 | 1.0 | 2 | 2.2 | 1 | 1.7 | 0.5 | 22 | 3 | 3 | 0 | 0 | 0 | ** |
| I10. Include the effects of a/ | 2 | 3 | 1.5 | 2 | 2.5 | 2 | 2.0 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| I11. Provide realistic VISMODs | 2 | 3 | 1.5 | 2 | 2.3 | 2 | 2.2 | 0.5 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| I12. Provide video coverage to | 2 | 3 | 1.5 | 3 | 2.5 | 2 | 2.3 | 0.5 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| J. ARTILLERY & MORTARS | | | | | | | | | | | | | | | |
| J1. Loading rounds - procedure | 1 | 3 | 2.3 | 3 | 2.5 | 2 | 2.3 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| J2. Loading rounds - weight of | 1 | 3 | 2.3 | 3 | 2.6 | 3 | 2.3 | 0.9 | 22 | 1 | 1 | 4 | 0 | 0 | * |
| J3. Loading rounds - loading t | 1 | 3 | 2.0 | 3 | 2.5 | 2 | 2.3 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| J4. Laying the weapon | 3 | 2 | 2.0 | 1 | 2.0 | 1 | 2.0 | 0.7 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| J5. Firing the weapon - proced | 1 | 2 | 2.3 | 1 | 1.9 | 1 | 1.9 | 0.7 | 22 | 3 | 3 | 0 | 0 | 0 | ** |
| J6. Firing the weapon - recoil | 3 | 2 | 3.0 | 3 | 2.6 | 1 | 2.5 | 0.8 | 22 | 1 | 1 | 4 | 0 | 0 | * |
| J7. Firing the weapon - flash, | 1 | 2 | 2.7 | 2 | 2.3 | 2 | 2.2 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| J8. Adjustment of fire | 2 | 2 | 2.3 | 1 | 1.7 | 1 | 1.5 | 0.5 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| J9. Target area cues for Forwa | 1 | 2 | 1.7 | 1 | 1.8 | 2 | 1.6 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| J10. Use of Battery Computer S | 1 | 2 | 2.0 | 1 | 2.6 | 1 | 1.6 | 0.6 | 20 | 3 | 2 | 1 | 0 | 0 | ** |
| J11. Use of TACFIRE | 1 | 2 | 2.0 | 1 | 2.3 | 1 | 1.6 | 0.6 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| J12. Simulate/replicate entire | 2 | 3 | 2.3 | 3 | 2.4 | 1 | 2.1 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| J13. Simulate loss of communic | 2 | 4 | 2.3 | 3 | 2.5 | 2 | 2.5 | 0.7 | 22 | 0 | 4 | 1 | 1 | 0 | |
| J14. Defense of area | 1 | 3 | 1.7 | 4 | 2.4 | | 2.4 | 0.8 | 21 | 1 | 2 | 1 | 1 | 0 | * |
| J15. Counter battery fire | 1 | 3 | 3.0 | 2 | 2.6 | 2 | 1.9 | 0.7 | 22 | 1 | 2 | 3 | 0 | 0 | ** |
| J16. Direct fire | 1 | 3 | 2.3 | 2 | 2.9 | 3 | 1.9 | 0.6 | 21 | 1 | 2 | 3 | 0 | 0 | ** |
| J17. Improved munitions( i.e. | 2 | 3 | 2.0 | 2 | 2.7 | 1 | 1.9 | 0.6 | 21 | 1 | 3 | 2 | 0 | 0 | ** |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J18. Selection, use, conservat | 2 | 3 | 2.7 | 2 | 2.5 | 3 | 2.2 | 0.7 | 22 | 0 | 2 | 4 | 0 | 0 * |
| K. ARTILLERY & MORTAR EFFECTS | | | | | | | | | | | | | | |
| K1. Flash of incoming rounds | 1 | 2 | 2.0 | 2 | 2.1 | 3 | 1.9 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 ** |
| K2. Bang of incoming rounds | 1 | 2 | 2.0 | 2 | 2.1 | 2 | 1.9 | 0.5 | 22 | 1 | 5 | 0 | 0 | 0 ** |
| K3. Smoke of incoming rounds | 1 | 2 | 2.0 | 2 | 2.1 | 3 | 2.0 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 ** |
| K4. Simulated ground burst | 1 | 2 | 2.3 | 2 | 2.0 | 1 | 1.8 | 0.5 | 22 | 2 | 4 | 0 | 0 | 0 ** |
| K5. Simulated air burst | 1 | 2 | 2.3 | 3 | 2.0 | 1 | 2.0 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 ** |
| K6. Attrition of vehicles | 1 | 2 | 2.0 | 1 | 2.1 | 1 | 1.6 | 0.5 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| K7. Attrition of vehicle crews | 1 | 2 | 2.0 | 1 | 2.0 | 1 | 1.5 | 0.5 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| K8. Attrition of dismounted tr | 2 | 2 | 2.0 | 1 | 1.9 | 1 | 1.6 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 ** |
| K9. Suppression | 1 | 3 | 2.0 | 1 | 2.0 | 2 | 1.9 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 ** |
| K10. Simulation of damage to b | 2 | 3 | 2.7 | 3 | 2.7 | 3 | 2.6 | 0.5 | 22 | 0 | 1 | 5 | 0 | 0 |
| K11. Simulation of damage to s | 2 | 3 | 2.3 | 3 | 2.6 | 3 | 2.5 | 0.4 | 22 | 0 | 2 | 4 | 0 | 0 |
| K12. Real-time casualty assess | 1 | 2 | 2.0 | 1 | 1.9 | 1 | 1.6 | 0.7 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| K13. Adjustment of fire | 1 | 2 | 1.7 | 1 | 1.8 | 1 | 1.5 | 0.5 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| K14. Round-for-round-simulatio | 1 | 2 | 1.7 | 2 | 2.0 | 2 | 2.0 | 0.6 | 22 | 1 | 5 | 0 | 0 | 0 ** |
| K15. Surprise | 1 | 2 | 1.7 | 1 | 2.1 | 3 | 1.9 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 *** |
| K16. Time fidelity for receipt | 1 | 2 | 1.7 | 1 | 2.0 | 1 | 1.7 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| L. MINES | | | | | | | | | | | | | | |
| L1. Replicate the size of the | 1 | 2 | 1.3 | 2 | 2.1 | 3 | 2.2 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 * |
| L2. Replicate the weight of th | 1 | 3 | 1.3 | 2 | 2.3 | 3 | 2.3 | 0.8 | 22 | 2 | 2 | 2 | 0 | 0 * |
| L3. Replicate the trip mechani | 1 | 2 | 1.3 | 1 | 1.9 | 2 | 1.8 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| L4. Reproduce detection charac | 1 | 2 | 1.7 | 1 | 2.0 | 1 | 1.7 | 0.5 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| L5. Simulate mines on a one-fo | 1 | 3 | 2.0 | 4 | 2.2 | 1 | 2.3 | 0.7 | 22 | 2 | 2 | 1 | 1 | 0 * |
| L6. Simulate mines on a generi | 1 | 2 | 1.7 | 1 | 2.5 | 2 | 2.1 | 0.7 | 22 | 2 | 3 | 1 | 0 | 0 * |
| L7. Simulate the attrition and | 1 | 2 | 1.3 | 1 | 2.2 | 1 | 1.8 | 0.7 | 22 | 4 | 2 | 0 | 0 | 0 ** |
| L8. Simulate only the overall | 2 | 3 | 3.7 | 5 | 2.3 | 2 | 2.4 | 0.8 | 22 | 0 | 3 | 1 | 1 | 1 * |
| 19. Provide for simulating the | 2 | 3 | 1.3 | 3 | 2.5 | 3 | 2.5 | 0.7 | 22 | 1 | 1 | 4 | 0 | 0 |
| L10. Provide for simulating em | 1 | 3 | 1.7 | 3 | 2.1 | 2 | 2.1 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 * |
| L11. Provide for simulating ar | 1 | 3 | 2.0 | 2 | 2.0 | 2 | 2.1 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 * |
| L12. Provide for simulating di | 1 | 4 | 1.7 | 1 | 2.0 | 2 | 2.1 | 0.7 | 22 | 2 | 3 | 0 | 1 | 0 * |
| L13. Provide for simulating br | 1 | 3 | 2.0 | 1 | 1.9 | 1 | 1.8 | 0.6 | 22 | 3 | 2 | 1 | 0 | 0 ** |
| L14. Provide for simulating br | 1 | 3 | 2.0 | 3 | 2.2 | | 2.3 | 0.6 | 21 | 1 | 2 | 2 | 0 | 0 * |
| L15. Provide real-time casualt | 1 | 2 | 1.3 | 2 | 2.1 | 1 | 1.6 | 0.7 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| L16. Provides real-time casual | 1 | 2 | 1.3 | 1 | 2.1 | 1 | 1.6 | 0.7 | 22 | 4 | 2 | 0 | 0 | 0 ** |
| L17. Attrition of any player | 1 | 3 | 1.5 | 1 | 2.2 | 1 | 1.9 | 0.7 | 22 | 4 | 1 | 1 | 0 | 0 ** |
| L18. Attrition of only major w | 2 | 3 | 3.0 | 2 | 2.4 | 4 | 2.7 | 0.8 | 22 | 0 | 3 | 2 | 1 | 0 |
| L19. Mine reuse after using (r | 2 | 2 | 1.0 | 3 | 2.1 | 2 | 2.2 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 * |
| L20. Threat mine warfare | 2 | 2 | 1.5 | 2 | 2.1 | 1 | 1.8 | 0.5 | 22 | 2 | 4 | 0 | 0 | 0 ** |
| M. NUCLEAR/BIOLOGICAL/CHEMICAL | | | | | | | | | | | | | | |
| M1. Training intended for indi | 1 | 2 | 2.3 | 1 | 1.9 | | 2.1 | 0.8 | 21 | 2 | 3 | 0 | 0 | 0 * |
| M2. Training intended for NBC | 1 | 3 | 1.7 | 2 | 1.6 | | 1.9 | 0.5 | 21 | 1 | 3 | 1 | 0 | 0 ** |
| M3. NBC training exercises sim | 5 | 3 | 4.7 | 3 | 2.6 | | 3.4 | 1.0 | 21 | 0 | 0 | 3 | 0 | 2 xxx |
| M4. Integrated N<B< and C trai | 1 | 2 | 1.3 | 2 | 1.7 | 1 | 1.7 | 0.4 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| M5. Use of notional units and | 5 | 4 | 4.0 | 2 | 2.7 | | 2.9 | 0.8 | 21 | 0 | 1 | 1 | 2 | 1 |
| M6. Different NBC simulant rea | 2 | 2 | 2.7 | 5 | 2.0 | 1 | 2.3 | 0.9 | 22 | 1 | 3 | 1 | 0 | 1 * |
| M7. Use NBC warning and report | 1 | 1 | 1.3 | 2 | 1.6 | 1 | 1.6 | 0.5 | 22 | 4 | 2 | 0 | 0 | 0 ** |
| M8. NBC monitoring and survey | 1 | 2 | 1.3 | 2 | 1.7 | 1 | 1.8 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 ** |
| M9. NBC simulation devices us | 2 | 2 | 1.7 | 2 | 1.7 | 1 | 1.9 | 0.6 | 22 | 1 | 5 | 0 | 0 | 0 ** |
| M10. NBC Simulation training d | 1 | 2 | 1.7 | 3 | 2.1 | | 2.1 | 0.7 | 21 | 1 | 3 | 1 | 0 | 0 * |
| M11. Flash/bang/smoke cues for | 2 | 2 | 1.7 | 1 | 2.1 | 2 | 2.1 | 0.4 | 21 | 1 | 5 | 0 | 0 | 0 * |
| M12. Traveling through a simul | 1 | 2 | 1.3 | 1 | 1.9 | 1 | 1.8 | 0.5 | 21 | 4 | 2 | 0 | 0 | 0 ** |
| M13. Nuclear training should be provided for unit size of: | | | | | | | | | | | | | | |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M13. Squad | 1 | 2 | 2.3 | 1 | 1.6 | | 2.0 | 1.0 | 20 | 2 | 3 | 0 | 0 | 0 | ** |
| M13. Platoon | 1 | 2 | 2.0 | 2 | 1.7 | | 1.9 | 0.6 | 20 | 1 | 4 | 0 | 0 | 0 | ** |
| M13. Company | 2 | 2 | 1.3 | 2 | 1.6 | 1 | 1.8 | 0.6 | 21 | 2 | 4 | 0 | 0 | 0 | ** |
| M13. Battalion/task force | 4 | 2 | 1.0 | 3 | 2.2 | 1 | 2.0 | 0.7 | 21 | 2 | 2 | 1 | 1 | 0 | * |
| M13 Larger than battalion | 4 | | 2.0 | 3 | 3.0 | 1 | 2.6 | 0.6 | 20 | 1 | 1 | 2 | 1 | 0 | |
| M14. Nuclear simulation should provide for: | | | | | | | | | | | | | | | |
| M14. Total dose | 2 | 3 | 2.0 | 2 | 1.9 | | 2.3 | 0.8 | 19 | 0 | 4 | 1 | 0 | 0 | * |
| M14. Dose rate | 2 | 2 | 2.0 | 1 | 1.8 | | 2.1 | 0.7 | 19 | 1 | 4 | 0 | 0 | 0 | * |
| M14. Dose rate and total d | 1 | 2 | 3.0 | 2 | 1.6 | 1 | 2.0 | 0.8 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| M14 Armor protection | 3 | 2 | 2.3 | 2 | 1.9 | 1 | 2.2 | 0.7 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| M14 EMP/TREE simulation | 2 | | 2.0 | 2 | 1.9 | 1 | 2.2 | 0.6 | 19 | 1 | 4 | 0 | 0 | 0 | * |
| M15. Simulation of biological | 3 | 3 | 2.0 | 1 | 2.2 | 3 | 2.4 | 0.8 | 21 | 1 | 2 | 3 | 0 | 0 | * |
| M16. Simulation of biological | 3 | 3 | 2.0 | 1 | 2.3 | 3 | 2.5 | 0.8 | 21 | 1 | 2 | 3 | 0 | 0 | * |
| M17. Simulation of contamination transfer: | | | | | | | | | | | | | | | |
| M17 To interiors of armored | 1 | 3 | 2.0 | 1 | 2.3 | 2 | 2.4 | 0.8 | 21 | 2 | 3 | 1 | 0 | 0 | * |
| M17 From one area to anoth | 1 | 3 | 2.3 | 1 | 2.2 | 2 | 2.3 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 | * |
| M18. Provide surprise delivery | 1 | 2 | 1.3 | 1 | 1.9 | 2 | 1.9 | 0.6 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| M19. Provide surprise CS and | 1 | 2 | 1.3 | 1 | 2.0 | 2 | 2.0 | 0.6 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| M20. Persistent simulant decon | 1 | 3 | 1.7 | 2 | 1.9 | 1 | 2.0 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| M21. Simulation of nonpersiste | 3 | 2 | 1.3 | 2 | 1.9 | 1 | 1.9 | 0.6 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| M22. Simulation of persistent | 1 | 2 | 1.7 | 2 | 2.0 | 1 | 1.9 | 0.5 | 21 | 2 | 4 | 0 | 0 | 0 | ** |
| M23. Delivery of chemical agen | 2 | 2 | 2.7 | 2 | 2.2 | 2 | 2.3 | 0.5 | 21 | 0 | 5 | 1 | 0 | 0 | * |
| M24. Delivery of chemical agen | 1 | 2 | 2.7 | 2 | 2.1 | 2 | 2.1 | 0.6 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| M25. Real-time casualty assess | 1 | 2 | 1.3 | 1 | 2.0 | 1 | 1.6 | 0.6 | 21 | 4 | 2 | 0 | 0 | 0 | ** |
| M26. Training in all MOPP leve | 1 | 2 | | 1 | 1.4 | 2 | 1.4 | 0.5 | 21 | 3 | 2 | 0 | 0 | 0 | *** |
| N. MOUT | | | | | | | | | | | | | | | |
| N1. Indication of simulated da | 2 | | 1.5 | 3 | 2.8 | 1 | 2.2 | 0.7 | 20 | 2 | 1 | 2 | 0 | 0 | * |
| N2. Simulate the protection pr | 1 | | 1.5 | 2 | 2.3 | 1 | 1.9 | 0.7 | 21 | 3 | 2 | 0 | 0 | 0 | ** |
| N3. Simulate protection degrad | 2 | | 1.5 | 3 | 2.5 | 2 | 2.1 | 0.6 | 20 | 1 | 3 | 1 | 0 | 0 | * |
| N4. Casualties on personnel in | 1 | | 1.5 | 1 | 2.3 | 1 | 1.8 | 0.7 | 20 | 4 | 1 | 0 | 0 | 0 | ** |
| N5. Simulate TES weapons insid | 1 | | 1.5 | 1 | 2.1 | | 1.8 | 0.8 | 20 | 3 | 1 | 0 | 0 | 0 | ** |
| N6. Engage at night | 1 | | 1.5 | 1 | 2.1 | 1 | 1.6 | 0.5 | 20 | 4 | 1 | 0 | 0 | 0 | ** |
| N7. Engage through obscurants | 2 | | 1.5 | 2 | 2.3 | 2 | 1.9 | 0.4 | 20 | 1 | 4 | 0 | 0 | 0 | ** |
| N8. Engage at very close range | 2 | | 1.5 | 1 | 2.1 | 1 | 1.8 | 0.5 | 20 | 3 | 2 | 0 | 0 | 0 | ** |
| N9. Simulate attrition from us | 2 | | 1.0 | 2 | 2.6 | 2 | 2.2 | 0.5 | 20 | 1 | 3 | 1 | 0 | 0 | * |
| N10. Emphasize the instrumenta | 2 | | 1.5 | 3 | 2.1 | | 2.2 | 0.8 | 19 | 1 | 2 | 1 | 0 | 0 | * |
| N11. Cues in MOUT: | | | | | | | | | | | | | | | |
| N11. Weapon firing | 1 | | 1.5 | 1 | 1.9 | 1 | 1.6 | 0.7 | 21 | 4 | 1 | 0 | 0 | 0 | ** |
| N11. Noise | 1 | | 1.5 | 1 | 2.0 | 1 | 1.8 | 0.7 | 21 | 4 | 1 | 0 | 0 | 0 | ** |
| N11. Flash | 2 | | 1.5 | 1 | 2.1 | 2 | 1.9 | 0.5 | 21 | 2 | 3 | 0 | 0 | 0 | ** |
| N11. Smoke | 2 | | 1.5 | 1 | 2.1 | 2 | 1.9 | 0.6 | 21 | 2 | 3 | 0 | 0 | 0 | ** |
| N11. Pellets, dye or color | 3 | | 1.5 | 1 | 2.5 | 3 | 2.3 | 0.9 | 21 | 2 | 1 | 2 | 0 | 0 | * |
| N11. Hit signatures | 3 | | 1.5 | 1 | 2.3 | 3 | 2.2 | 0.9 | 21 | 2 | 1 | 2 | 0 | 0 | * |
| N11. Smoke from burning bu | 2 | | 2.0 | 2 | 2.5 | 3 | 2.3 | 0.7 | 21 | 0 | 4 | 1 | 0 | 0 | * |
| O. COMMAND AND CONTROL | | | | | | | | | | | | | | | |
| O1. Instrument command and con | 3 | | 1.3 | 3 | 2.1 | 1 | 1.8 | 0.7 | 21 | 2 | 1 | 2 | 0 | 0 | ** |
| O2. Simulate command and contr | 2 | | 1.7 | 4 | 2.2 | 2 | 2.3 | 0.8 | 21 | 0 | 4 | 0 | 1 | 0 | * |
| O3. Provide command and contro | 2 | | 2.7 | 5 | 2.5 | 2 | 2.5 | 0.9 | 21 | 0 | 3 | 1 | 0 | 1 | |
| O4. Simulate tactical command | 2 | | 3.0 | 3 | 2.4 | 2 | 2.2 | 0.7 | 21 | 0 | 3 | 2 | 0 | 0 | * |
| O5. Simulate or provide artill | 1 | | 2.3 | 2 | 1.9 | 2 | 1.9 | 0.5 | 21 | 1 | 4 | 0 | 0 | 0 | ** |
| O6. Provide TES data or video | 1 | | 1.7 | 2 | 2.1 | 3 | 1.9 | 0.6 | 21 | 1 | 3 | 1 | 0 | 0 | ** |
| O7. Provide TES communications | 2 | | 1.3 | 2 | 2.0 | 3 | 2.0 | 0.5 | 21 | 1 | 3 | 1 | 0 | 0 | * |
| P. COMBAT SUPPORT | | | | | | | | | | | | | | | |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PNS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1. Instrument combat support | 1 | | 2.0 | 3 | 2.7 | | 2.4 | 0.8 | 19 | 1 | 1 | 2 | 0 | 0 | * |
| P2. Instrument combat support | 1 | | 2.0 | 2 | 2.7 | | 2.5 | 0.9 | 19 | 1 | 2 | 1 | 0 | 0 | |
| P3. Instrument all potential c | 1 | 2 | 2.0 | 2 | 2.5 | 2 | 2.0 | 0.5 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| P4. Simulate combat support an | 1 | 3 | 3.0 | 4 | 2.6 | 2 | 2.6 | 0.8 | 22 | 1 | 1 | 3 | 1 | 0 | |
| P5. Provide logistics realism | 1 | 2 | 2.3 | 1 | 1.9 | 2 | 1.7 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| P6. Provide for field medical | 2 | 2 | 1.7 | 1 | 2.0 | 3 | 1.9 | 0.5 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| P7. Provide for problems of ca | 2 | 2 | 2.3 | 1 | 1.9 | 2 | 2.0 | 0.6 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| P8. Provide for problems of re | 2 | 2 | 2.0 | 1 | 1.9 | 1 | 1.8 | 0.5 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| P9. Provide for problems of da | 2 | 2 | 2.7 | 1 | 2.0 | 1 | 2.0 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| Q. COMMUNICATION DISRUPTION | | | | | | | | | | | | | | | |
| Q1. Provide for the simulated | 2 | 3 | 1.3 | 4 | 1.9 | 1 | 1.9 | 0.7 | 22 | 2 | 2 | 1 | 1 | 0 | ** |
| Q2. Provide for the actual dis | 2 | 2 | 2.7 | 1 | 2.1 | 2 | 2.1 | 0.6 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| Q3. Use actual RF jamming tech | 2 | 3 | 1.3 | 1 | 2.0 | 1 | 1.9 | 0.7 | 22 | 3 | 2 | 1 | 0 | 0 | ** |
| Q4. Disrupt communications by | 2 | 2 | 2.3 | 3 | 2.0 | 2 | 2.2 | 0.6 | 22 | 0 | 5 | 1 | 0 | 0 | * |
| Q5. Disrupt only selected chan | 3 | 3 | 1.3 | 1 | 2.2 | 4 | 2.5 | 0.9 | 22 | 2 | 1 | 2 | 1 | 0 | * |
| Q6. Automatically attrit elect | 2 | 4 | 2.3 | 2 | 2.5 | 4 | 2.4 | 0.8 | 22 | 0 | 4 | 0 | 2 | 0 | * |
| Q7. Penalize excessive transmi | 2 | 3 | 1.0 | 1 | 1.7 | 2 | 2.0 | 0.7 | 22 | 2 | 3 | 1 | 0 | 0 | * |
| Q8. Simulate communication equ | 2 | 2 | 1.7 | 2 | 2.2 | 2 | 2.2 | 0.5 | 22 | 0 | 6 | 0 | 0 | 0 | * |
| Q9. Allow simulated repair of | 2 | 3 | 1.7 | 2 | 2.3 | 1 | 2.3 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| Q10. Provide for antenna blowo | 2 | 2 | 1.3 | 1 | 2.1 | 2 | 2.1 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 | * |
| Q11. Simulate EMI on electroni | 2 | 3 | 1.3 | 1 | 2.1 | 2 | 2.1 | 0.6 | 21 | 2 | 3 | 1 | 0 | 0 | * |
| Q12. Simulate EMI on computers | 3 | 2 | 1.7 | 1 | 2.2 | 2 | 2.1 | 0.6 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| R. OPFOR | | | | | | | | | | | | | | | |
| R0. OPFOR is not necessary | | | | | | | | | | | | | | | |
| R1. Threat maneuver tactics an | 1 | 2 | 1.3 | 1 | 1.4 | 1 | 1.3 | 0.3 | 21 | 5 | 1 | 0 | 0 | 0 | *** |
| R2. Actual OPFOR vehicles | 2 | 3 | 1.3 | 3 | 2.0 | 2 | 2.3 | 0.8 | 21 | 1 | 3 | 2 | 0 | 0 | * |
| R3. VISMODS for OPFOR vehicles | 3 | 2 | 1.7 | 2 | 1.8 | 1 | 1.8 | 0.5 | 21 | 1 | 4 | 1 | 0 | 0 | ** |
| R4. Actual threat weapons | 2 | 3 | 1.3 | 3 | 1.9 | 2 | 2.3 | 0.6 | 21 | 1 | 3 | 2 | 0 | 0 | * |
| R5. Threat weapons characteris | 2 | 2 | 1.3 | 2 | 2.1 | 1 | 1.7 | 0.5 | 21 | 2 | 4 | 0 | 0 | 0 | ** |
| R6. Threat weapon performance: | | | | | | | | | | | | | | | |
| R6. Available capability | 3 | 2 | 2.0 | 1 | 1.7 | | 1.9 | 0.7 | 20 | 1 | 3 | 1 | 0 | 0 | ** |
| R6. Latest (classified) cap | 3 | 3 | 1.7 | 2 | 2.0 | 1 | 2.1 | 0.8 | 21 | 1 | 3 | 2 | 0 | 0 | * |
| R7. Simulation of threat target vulnerability: | | | | | | | | | | | | | | | |
| R7. Available ( unclassifie | 2 | 2 | 2.0 | 1 | 1.8 | | 1.8 | 0.6 | 20 | 1 | 4 | 0 | 0 | 0 | ** |
| R7. Latest (classified) cap | 2 | 3 | 1.3 | 2 | 1.9 | 1 | 2.0 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| R8. Threat uniforms | 1 | 2 | 1.0 | 3 | 1.9 | 2 | 1.9 | 0.6 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| S. OBSCURATION | | | | | | | | | | | | | | | |
| S1. Shoot through obscurants | 3 | 2 | 1.0 | 1 | 2.2 | 1 | 1.8 | 0.7 | 22 | 3 | 2 | 1 | 0 | 0 | ** |
| S2. Sight through obscurants | 3 | 2 | 2.3 | 2 | 2.4 | 1 | 1.9 | 0.5 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| S3. Shoot through soft cover | 3 | 2 | 1.3 | 3 | 2.2 | 2 | 2.1 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| S4. Provide IR-opaque training | 3 | | 2.0 | 1 | 2.4 | 2 | 2.1 | 0.8 | 21 | 1 | 3 | 1 | 0 | 0 | * |
| S5. Simulate only the effects | 3 | | 4.5 | | 2.4 | 1 | 2.5 | 0.8 | 20 | 1 | 1 | 1 | 1 | 0 | * |
| S6. Simulate delivery of obscu | 3 | 2 | 1.7 | 2 | 2.2 | 2 | 2.2 | 0.5 | 22 | 0 | 5 | 1 | 0 | 0 | |
| S7. Simulate delivery of obscu | 3 | 2 | 1.7 | 2 | 2.3 | 2 | 2.2 | 0.5 | 22 | 0 | 5 | 1 | 0 | 0 | * |
| T. SIGNATURES | | | | | | | | | | | | | | | |
| T1. Hit flash | 3 | 2 | 2.3 | 1 | 1.7 | 1 | 1.8 | 0.7 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| T2. Kill smoke | 3 | 2 | 1.7 | 1 | 1.7 | 1 | 1.7 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| T3. Weapon flash | 2 | 2 | 1.7 | 1 | 1.9 | 2 | 1.7 | 0.6 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| T4. Weapon smoke | 2 | 2 | 2.7 | 2 | 2.1 | 3 | 1.9 | 0.6 | 22 | 0 | 4 | 2 | 0 | 0 | ** |
| T5. Weapon bang | 2 | 2 | 1.7 | 1 | 1.8 | 1 | 1.7 | 0.5 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| T6. Tracers | 2 | 2 | 1.7 | 2 | 1.9 | 1 | 1.8 | 0.6 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| T7. Burst on target | 2 | 2 | 1.7 | 1 | 1.9 | 1 | 1.8 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| T8. Incoming artillery or mort | 3 | 3 | 2.3 | 3 | 2.1 | 2 | 2.3 | 0.7 | 22 | 0 | 3 | 3 | 0 | 0 | * |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

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| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T9. Incoming artillery or mort | 2 | 3 | 2.0 | 3 | 2.0 | ? | 2.0 | 0.6 | 22 | 0 | 4 | 2 | 0 | 0 | ** |
| T10. Incoming artillery or mor | 2 | 2 | 1.7 | 1 | 2.2 | ? | 1.7 | 0.5 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| T11. Mine flash | 2 | 2 | 1.7 | 1 | 2.0 | 1 | 1.7 | 0.6 | 22 | 2 | 4 | 0 | 0 | 0 | ** |
| T12. Mine bang | 2 | 2 | 1.7 | 2 | 2.0 | 2 | 1.8 | 0.5 | 22 | 0 | 6 | 0 | 0 | 0 | ** |
| T13. Mine smoke | 3 | 2 | 2.0 | 1 | 2.3 | ? | 1.9 | 0.7 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| T14. Different signatures for | 3 | 2 | 2.0 | 1 | 2.3 | 1 | 1.8 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| T15. Different signatures for | 3 | 2 | 2.0 | 2 | 2.3 | ? | 2.0 | 0.6 | 22 | 0 | 5 | 1 | 0 | 0 | ** |
| T16. Signatures as cues for th | 3 | 2 | 1.7 | 1 | 1.9 | 1 | 1.7 | 0.5 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| T17. Signatures as cues for th | 3 | 2 | 4.0 | 3 | 2.2 | ? | 2.2 | 0.7 | 22 | 0 | 3 | 2 | 1 | 0 | * |
| T18. Signatures through sight | 3 | 2 | 3.0 | 3 | 2.1 | ? | 2.1 | 0.6 | 21 | 0 | 3 | 3 | 0 | 0 | * |
| U. ATTRITION | | | | | | | | | | | | | | | |
| T1. Multiple levels of hits on | 2 | 2 | 1.7 | 2 | 2.1 | 2 | 2.1 | 0.6 | 22 | 0 | 6 | 0 | 0 | 0 | * |
| T2. Higher probability of kill | 2 | 2 | 1.3 | 1 | 1.9 | 1 | 1.8 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 | ** |
| T3. Hit quadrant on a vehicle, | 2 | 2 | 1.3 | 2 | 2.1 | ? | 2.1 | 0.7 | 22 | 1 | 5 | 0 | 0 | 0 | * |
| T4. The effect on the probabil | 3 | 3 | 2.0 | 2 | 2.1 | 1 | 2.3 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| T5. Multiple levels on individ | 2 | 3 | 2.0 | 3 | 2.4 | ? | 2.6 | 0.6 | 22 | 0 | 4 | 2 | 0 | 0 | |
| T6. Head shot on individuals ( | 1 | 3 | 1.7 | 2 | 2.1 | ? | 2.3 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| T7. Indication of who shot who | 1 | 3 | 1.7 | 4 | 2.1 | 1 | 2.1 | 0.7 | 22 | 2 | 2 | 1 | 1 | 0 | * |
| T8. Distinguish/identify frien | 2 | 3 | 1.0 | 2 | 2.0 | 1 | 2.0 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| V. CASUALTY ASSESSMENT | | | | | | | | | | | | | | | |
| V1. For vehicles, loss of mobi | 3 | 3 | 1.7 | 1 | 2.0 | 1 | 1.8 | 0.6 | 22 | 2 | 2 | 2 | 0 | 0 | ** |
| V2. Loss of radio | 3 | 4 | 2.0 | 2 | 2.1 | 2 | 2.2 | 0.7 | 22 | 0 | 4 | 1 | 1 | 0 | * |
| V3. Attrition of individual cr | 3 | 3 | 1.7 | 1 | 2.0 | 2 | 2.0 | 0.6 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| V4. Casualty assessed automati | 4 | 3 | 1.7 | 5 | 2.0 | 1 | 2.2 | 1.0 | 22 | 1 | 2 | 1 | 1 | 1 | * |
| V5. Indication for the medics, | 4 | 3 | 2.0 | 3 | 2.2 | 2 | 2.5 | 0.6 | 22 | 0 | 3 | 2 | 1 | 0 | * |
| V6. Elimination of controller- | 4 | 3 | 1.3 | 3 | 2.5 | 1 | 2.6 | 0.8 | 22 | 2 | 1 | 2 | 1 | 0 | |
| W. INTEROPERABILITY | | | | | | | | | | | | | | | |
| W1. MILES | 1 | 2 | 1.0 | 1 | 1.4 | 1 | 1.4 | 0.5 | 21 | 5 | 1 | 0 | 0 | 0 | *** |
| W2. UCOFT, or similar crew tra | 2 | | | 2 | 2.4 | 4 | 2.3 | 0.8 | 19 | 0 | 3 | 0 | 1 | 0 | * |
| W3. TWGSS, or similar gunnery | 2 | 3 | | 1 | 2.3 | 1 | 2.0 | 0.7 | 19 | 2 | 2 | 1 | 0 | 0 | ** |
| W4. ARTBASS, or other staff tr | 3 | 2 | | 2 | 2.2 | 4 | 2.3 | 0.8 | 19 | 0 | 3 | 1 | 1 | 0 | * |
| W5. Test instrumentation such | 3 | | 2.0 | 5 | 2.6 | | 2.4 | 1.0 | 18 | 0 | 1 | 2 | 0 | 1 | * |
| W6. Other NATO TES systems suc | 3 | 2 | | 2 | 2.8 | 2 | 2.5 | 0.6 | 19 | 0 | 3 | 2 | 0 | 0 | * |
| W7. Future new equipment capab | 2 | 2 | 2.0 | 1 | 1.9 | 1 | 1.7 | 0.5 | 21 | 2 | 4 | 0 | 0 | 0 | ** |
| W8. Future improvements to cur | 2 | 2 | 1.5 | 1 | 1.9 | 1 | 1.7 | 0.5 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| W9. Future threat equipment an | 3 | 2 | 1.5 | 1 | 1.8 | 1 | 1.9 | 0.6 | 21 | 3 | 2 | 1 | 0 | 0 | ** |
| X. CHEATING | | | | | | | | | | | | | | | |
| X0. Cheating is not important in design of future TES system | | | | | | | | | | | | | | | |
| X1. System should be as cheat | 1 | 1 | 1.0 | 3 | 1.4 | 2 | 1.5 | 0.6 | 22 | 4 | 1 | 1 | 0 | 0 | ** |
| X2. TES systems should display | 1 | 1 | 2.0 | 3 | 1.8 | 4 | 2.1 | 0.8 | 22 | 2 | 2 | 1 | 1 | 0 | * |
| X3. Use of MILES-type keys sho | 2 | 2 | 2.0 | 3 | 2.3 | 3 | 2.4 | 0.5 | 21 | 0 | 4 | 2 | 0 | 0 | * |
| X4. Equipment should be made m | 1 | 2 | 1.5 | 2 | 1.8 | 3 | 1.9 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| X5. The number of soldier-oper | 1 | 2 | 1.7 | 1 | 1.7 | 1 | 1.8 | 0.6 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| X6. More functions should be d | 2 | 2 | 2.0 | 5 | 3.0 | 4 | 3.2 | 0.9 | 21 | 0 | 3 | 1 | 1 | 1 | xxx |
| Y. CONTROLLERS | | | | | | | | | | | | | | | |
| Y1. Control the flow of the ex | 1 | 1 | 1.3 | 3 | 1.9 | 4 | 1.9 | 0.8 | 22 | 3 | 1 | 1 | 1 | 0 | ** |
| Y2. Arbitrate problems and dis | 1 | 2 | 1.3 | 2 | 1.8 | 3 | 1.9 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| Y3. Evaluate trainees | 2 | 2 | 1.7 | 1 | 2.0 | 1 | 2.1 | 0.7 | 22 | 2 | 4 | 0 | 0 | 0 | * |
| Y4. Assess casualties | 2 | 2 | 4.0 | 4 | 2.4 | 4 | 2.6 | 0.9 | 22 | 0 | 3 | 0 | 3 | 0 | |
| Y5. Prevent cheating | 1 | 1 | 1.7 | 2 | 1.9 | 3 | 2.0 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | * |
| Y6. Emphasis should be placed | 1 | 2 | 2.0 | 1 | 1.9 | 1 | 1.8 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 | ** |
| Y7. More use should be made of | 1 | 3 | 4.0 | 4 | 3.6 | 5 | 3.5 | 0.9 | 22 | 1 | 0 | 1 | 3 | 1 | xxx |
| Y8. TES systems should be desi | 1 | 2 | 1.5 | 3 | 2.0 | ? | 1.9 | 0.6 | 22 | 2 | 3 | 1 | 0 | 0 | ** |

PNS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PWS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z. POSITION LOCATION | | | | | | | | | | | | | | | |
| Z1. Location of every player | 2 | 3 | 3.3 | 5 | 2.8 | 5 | 2.9 | 0.9 | 22 | 0 | 1 | 3 | 0 | 2 | |
| Z2. Location of major weapons | 2 | 3 | 2.3 | 4 | 2.1 | 2 | 2.0 | 0.7 | 22 | 0 | 4 | 1 | 1 | 0 | ** |
| Z3. Location of all but dismou | 2 | 3 | 2.3 | 5 | 2.5 | 3 | 2.7 | 0.8 | 22 | 0 | 3 | 2 | 0 | 1 | |
| Z4. Location to within 100 met | 2 | 3 | 3.3 | 4 | 2.7 | 2 | 2.6 | 0.8 | 22 | 0 | 2 | 3 | 1 | 0 | |
| Z5. Location to within 10 mete | 3 | 4 | 2.3 | 5 | 2.4 | 3 | 2.5 | 0.9 | 21 | 0 | 2 | 2 | 1 | 1 | |
| Z6. Location to within 1 mete | 3 | 4 | 4.3 | 5 | 3.3 | 3 | 3.4 | 0.5 | 21 | 0 | 0 | 3 | 2 | 1 | xxx |
| Z7. Include altitude as well a | 3 | 4 | 3.0 | 3 | 2.9 | 3 | 2.9 | 0.5 | 21 | 0 | 0 | 5 | 1 | 0 | |
| Z8. Include orientation of veh | 3 | 4 | 2.3 | 4 | 2.7 | 2 | 2.8 | 0.6 | 21 | 0 | 2 | 2 | 2 | 0 | |
| Z9. Include orientation of wea | 3 | 4 | 2.3 | 4 | 2.5 | 2 | 2.7 | 0.6 | 21 | 0 | 3 | 1 | 2 | 0 | |
| Z0. Location continuously upda | 3 | 4 | 3.3 | 3 | 2.5 | 1 | 2.5 | 0.7 | 21 | 1 | 1 | 3 | 1 | 0 | |
| Z1. Location needed only when | 2 | 2 | 3.0 | 3 | 2.7 | 2 | 2.5 | 0.7 | 21 | 0 | 3 | 3 | 0 | 0 | * |
| AA. INTERVISIBILITY | | | | | | | | | | | | | | | |
| AA0. Intervisibility not important in future training exercise | | | | | 1.0 | | 1.0 | 0.0 | 8 | 1 | 0 | 0 | 0 | 0 | *** |
| AA1. Include intervisibility i | 2 | 3 | 2.5 | 1 | 2.0 | 2 | 2.2 | 0.7 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| AA2. Include intervisibility i | 2 | 2 | 1.0 | 1 | 2.0 | 1 | 1.9 | 0.7 | 22 | 3 | 3 | 0 | 0 | 0 | ** |
| AA3. Provide intervisibility a | 3 | 1 | 3.0 | | 2.6 | 3 | 2.3 | 0.8 | 21 | 1 | 0 | 4 | 0 | 0 | * |
| BB. DATA COLLECTION | | | | | | | | | | | | | | | |
| BB1. Simplify field equipment | 2 | 1 | 4.3 | 2 | 2.4 | | 2.6 | 0.8 | 20 | 1 | 3 | 0 | 1 | 0 | |
| BB2. Provide for on-board stor | 2 | 2 | 3.0 | 1 | 2.3 | 1 | 2.1 | 0.7 | 21 | 2 | 3 | 1 | 0 | 0 | * |
| BB3. Provide for real-time dis | 2 | 3 | 1.7 | 3 | 2.1 | 3 | 2.2 | 0.7 | 21 | 0 | 3 | 3 | 0 | 0 | * |
| BB4. Provide video taping of o | 2 | 3 | 1.7 | 4 | 2.2 | 2 | 2.4 | 0.7 | 21 | 0 | 4 | 1 | 1 | 0 | * |
| BB5. Provide video taping of s | 2 | 2 | 2.7 | 4 | 2.3 | 3 | 2.5 | 0.7 | 21 | 0 | 3 | 2 | 1 | 0 | |
| BB6. Provide computer graphics | 2 | 3 | 1.3 | 3 | 2.4 | 2 | 2.2 | 0.6 | 21 | 1 | 3 | 2 | 0 | 0 | * |
| BB7. Include player position l | 2 | 3 | 2.7 | 4 | 2.7 | 1 | 2.3 | 0.7 | 21 | 1 | 1 | 3 | 1 | 0 | * |
| BB8. Include firing weapon ID | 2 | 2 | 1.3 | 1 | 2.2 | 3 | 2.0 | 0.6 | 21 | 2 | 3 | 1 | 0 | 0 | ** |
| CC. SIZE | | | | | | | | | | | | | | | |
| CC1. Future TES should be smal | 2 | 2 | 2.3 | 1 | 2.2 | 2 | 1.9 | 0.7 | 22 | 1 | 5 | 0 | 0 | 0 | ** |
| CC2. Size is more important th | 2 | 4 | 5.0 | 2 | 3.4 | 4 | 3.3 | 1.0 | 22 | 0 | 2 | 1 | 2 | 1 | xxx |
| CC3. Reduce size to improve tr | 2 | 3 | 3.5 | 2 | 2.4 | 3 | 2.2 | 0.7 | 22 | 0 | 3 | 3 | 0 | 0 | * |
| CC4. Eliminate helmet detector | 5 | 4 | 3.3 | 3 | 3.2 | 3 | 3.0 | 1.0 | 22 | 0 | 0 | 4 | 1 | 1 | |
| DD. WEIGHT | | | | | | | | | | | | | | | |
| DD1. The maximum wt. for TES equipment carried by infantry must be: | | | | | | | | | | | | | | | |
| DD1. Less than 2 pounds | 1 | 2 | 1.0 | 1 | 1.9 | 2 | 1.7 | 0.6 | 21 | 3 | 3 | 0 | 0 | 0 | ** |
| DD1. Less than 10 pounds | 2 | | 2.7 | 2 | 2.2 | 1 | 2.4 | 1.1 | 19 | 1 | 3 | 1 | 0 | 0 | * |
| DD1. Less than 20 pounds | 5 | | 5.0 | | 3.3 | 5 | 3.9 | 1.1 | 17 | 0 | 0 | 1 | 0 | 3 | xxx |
| DD2. The maximum weight for TES equipment on an helicopter must be: | | | | | | | | | | | | | | | |
| DD2. Less than 50 pounds | 2 | 2 | 2.0 | 1 | 1.3 | 2 | 1.7 | 0.6 | 20 | 2 | 4 | 0 | 0 | 0 | ** |
| DD2. Less than 200 pounds | 3 | | 3.0 | | 3.0 | 1 | 3.1 | 1.3 | 17 | 1 | 0 | 3 | 0 | 0 | xxx |
| DD3. The maximum weight for TES equipment on a fixed-wing a/c must be: | | | | | | | | | | | | | | | |
| DD3. Less than 50 pounds | 2 | 2 | 2.0 | 1 | 1.3 | 2 | 1.8 | 0.7 | 20 | 2 | 4 | 0 | 0 | 0 | ** |
| DD3. Less than 200 pounds | 3 | | 3.0 | | 2.8 | 1 | 2.8 | 1.3 | 17 | 1 | 0 | 3 | 0 | 0 | |
| EE. TYPE OF ELECTRICAL POWER | | | | | | | | | | | | | | | |
| EE1. Use of vehicle power when | 3 | 2 | 1.0 | 1 | 1.8 | 1 | 1.9 | 0.9 | 22 | 3 | 2 | 1 | 0 | 0 | ** |
| EE2. Use of special high perfo | 2 | 2 | 2.0 | 3 | 3.1 | 3 | 2.8 | 0.9 | 22 | 0 | 3 | 3 | 0 | 0 | |
| EE3. Use standard commercial b | 2 | 3 | 1.3 | 2 | 2.5 | 2 | 2.7 | 0.7 | 22 | 1 | 4 | 1 | 0 | 0 | |
| EE4. Use rechargeable batterie | 3 | 2 | 1.0 | 2 | 2.1 | 2 | 2.4 | 1.0 | 22 | 1 | 4 | 1 | 0 | 0 | * |
| EE5. Minimize use of batteries | 2 | 2 | 2.0 | 1 | 1.9 | 3 | 2.1 | 0.8 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| EE6. Use size and quantity of | 2 | 2 | 2.0 | 3 | 2.0 | 4 | 2.2 | 0.8 | 21 | 0 | 4 | 1 | 1 | 0 | * |
| FF. BUILT-IN TEST (BITE) | | | | | | | | | | | | | | | |
| FF0. BITE is not important to future TES | | | 1.0 | | 1.0 | | 1.0 | 0.0 | 10 | 2 | 0 | 0 | 0 | 0 | *** |
| FF1. BITE operable by user | 4 | 2 | 1.0 | 4 | 1.8 | 1 | 2.2 | 1.1 | 22 | 2 | 2 | 0 | 2 | 0 | * |
| FF2. BITE operable by repair p | 2 | 2 | 4.0 | 1 | 3.0 | 2 | 2.5 | 1.1 | 22 | 1 | 3 | 1 | 1 | 0 | * |

PWS QUESTIONNAIRE RESULTS FOR THE RESERVE COMPONENTS

TES PMS QUESTIONNAIRE RESULTS ONE VOTE PER ORGANIZATION

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FF3. Activates automatically | 3 | 3 | 1.5 | 2 | 2.1 | 1 | 2.2 | 0.6 | 22 | 2 | 2 | 2 | 0 | 0 | * |
| FF4. System-level BITE (Go/no | 3 | 3 | 5.0 | 1 | 2.3 | 2 | 2.4 | 1.1 | 22 | 1 | 2 | 2 | 0 | 1 | * |
| FF5. System-level BITE (which | 3 | 3 | 1.5 | 2 | 2.0 | 2 | 2.2 | 0.7 | 22 | 1 | 3 | 2 | 0 | 0 | * |
| FF6. Component level BITE (wha | 3 | 2 | 1.0 | 3 | 2.3 | 3 | 2.3 | 0.7 | 21 | 1 | 2 | 3 | 0 | 0 | * |
| GG. INSTALLATION | | | | | | | | | | | | | | | |
| GG1. More permanent installati | 3 | 3 | 1.0 | 3 | 2.8 | 3 | 2.6 | 0.9 | 21 | 1 | 0 | 5 | 0 | 0 | |
| GG2. Much easier to install th | 2 | 3 | 1.7 | 2 | 1.9 | 1 | 1.9 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| GG3. Installation at a TES ins | 3 | 5 | 2.5 | 4 | 3.9 | 4 | 3.6 | 1.0 | 20 | 0 | 1 | 1 | 3 | 1 | xxx |
| GG4. Installation anywhere in | 2 | 1 | 2.3 | 1 | 1.5 | 1 | 1.8 | 0.9 | 22 | 4 | 2 | 0 | 0 | 0 | ** |
| GG5. Installation by civilian | 3 | 2 | 4.5 | 4 | 3.9 | 4 | 3.5 | 0.9 | 20 | 0 | 1 | 1 | 4 | 0 | xxx |
| GG6. Installation by military | 2 | 2 | 2.7 | 1 | 1.9 | 1 | 1.9 | 1.0 | 22 | 2 | 3 | 1 | 0 | 0 | ** |
| GG7. Installation by specialis | 3 | 5 | 4.5 | 4 | 4.2 | 4 | 4.0 | 1.0 | 20 | 0 | 0 | 1 | 4 | 1 | xxx |
| HH. ISSUE | | | | | | | | | | | | | | | |
| HH1. At least some components | 4 | 4 | 2.7 | 3 | 4.2 | 4 | 3.8 | 1.0 | 21 | 0 | 0 | 2 | 4 | 0 | xxx |
| HH2. Future TES should be resi | 2 | 4 | 1.3 | 2 | 1.8 | 1 | 2.3 | 1.1 | 22 | 2 | 3 | 0 | 1 | 0 | * |
| HH3. Future TES should be issu | 2 | 2 | 4.3 | 1 | 3.2 | 4 | 2.6 | 1.1 | 21 | 1 | 2 | 1 | 2 | 0 | |
| HH4. TES equipment issued shou | 2 | 2 | 3.0 | 2 | 2.2 | 2 | 2.3 | 0.5 | 21 | 0 | 5 | 1 | 0 | 0 | * |
| HH5. Emphasis should be placed | 2 | 4 | 3.5 | 3 | 2.5 | 3 | 3.1 | 0.9 | 21 | 0 | 2 | 3 | 1 | 0 | xxx |
| HH6. TES equipment sets should | 2 | 3 | 1.7 | 3 | 1.8 | 2 | 2.1 | 0.9 | 21 | 0 | 4 | 2 | 0 | 0 | * |
| HH7. Each battalion should hav | 2 | 4 | 1.0 | 1 | 1.5 | 1 | 2.1 | 1.1 | 22 | 4 | 1 | 0 | 1 | 0 | * |
| II. MAINTENANCE | | | | | | | | | | | | | | | |
| II1. TES components designed f | 2 | 2 | 1.0 | 1 | 1.7 | 4 | 2.0 | 1.0 | 22 | 2 | 3 | 0 | 1 | 0 | * |
| II2. TES sys. designed for easy fault isolation: | | | | | | | | | | | | | | | |
| II2. By troops | 2 | 2 | 2.0 | 3 | 1.9 | 1 | 2.4 | 1.1 | 21 | 1 | 4 | 1 | 0 | 0 | * |
| II2. By TASC | 2 | 1 | 2.0 | 1 | 2.6 | 2 | 2.3 | 0.8 | 20 | 2 | 3 | 1 | 0 | 0 | * |
| II2. By CLS only | 3 | 1 | 2.0 | 3 | 4.0 | 3 | 3.1 | 1.1 | 19 | 1 | 1 | 3 | 1 | 0 | xxx |
| II3. Component replacement in | 2 | 2 | 1.3 | 2 | 1.8 | 2 | 2.2 | 1.0 | 21 | 1 | 5 | 0 | 0 | 0 | * |
| II4. Component replacement by | 2 | 2 | 2.0 | 3 | 2.8 | 1 | 2.5 | 0.9 | 20 | 1 | 3 | 2 | 0 | 0 | * |
| II5. Component repair by TASC | 2 | 2 | 2.0 | 2 | 2.6 | 3 | 2.4 | 0.8 | 20 | 0 | 4 | 2 | 0 | 0 | * |
| II6. Repair by military person | 2 | 2 | 1.0 | 3 | 1.9 | 4 | 2.5 | 1.0 | 21 | 1 | 3 | 1 | 1 | 0 | * |
| II7. Repair by civilian person | 2 | 2 | | 1 | 3.3 | 2 | 2.4 | 0.8 | 19 | 1 | 3 | 1 | 0 | 0 | * |
| JJ. TES EQUIPMENT TRAINING | | | | | | | | | | | | | | | |
| JJ1. Introduction to TES as pa | 1 | 2 | 1.0 | 2 | 2.0 | 1 | 2.1 | 0.6 | 22 | 3 | 3 | 0 | 0 | 0 | * |
| JJ2. Expand TES training to in | 2 | 2 | 1.3 | 1 | 2.2 | 2 | 2.3 | 0.8 | 22 | 2 | 4 | 0 | 0 | 0 | * |
| JJ3. Expand TES training to in | 2 | 3 | 1.7 | 3 | 2.1 | 3 | 2.7 | 0.8 | 22 | 0 | 3 | 3 | 0 | 0 | |
| JJ4. Provide more training aid | 2 | 3 | 2.0 | 2 | 2.2 | 2 | 2.6 | 0.8 | 22 | 0 | 5 | 1 | 0 | 0 | |
| JJ5. Provide more training aid | 2 | 3 | 2.3 | 3 | 2.2 | 3 | 2.7 | 0.7 | 22 | 0 | 3 | 3 | 0 | 0 | |
| JJ6. Provide videotapes for TE | 2 | 3 | 1.0 | 1 | 2.1 | 1 | 2.2 | 1.0 | 22 | 3 | 2 | 1 | 0 | 0 | * |
| JJ7. Provide simulators of TES | 2 | 3 | 2.7 | 3 | 2.3 | 2 | 2.6 | 0.8 | 22 | 0 | 3 | 3 | 0 | 0 | |
| JJ8. Provide training aids for | 2 | 2 | 1.3 | 2 | 2.2 | 1 | 2.3 | 0.9 | 22 | 2 | 4 | 0 | 0 | 0 | * |
| KK. TARGETS | | | | | | | | | | | | | | | |
| KK1. Cues to indicate hit or n | 1 | 2 | 1.5 | 1 | 1.5 | 2 | 1.7 | 0.7 | 22 | 4 | 2 | 0 | 0 | 0 | ** |
| KK2. Hit sensors on targets | 1 | 2 | 1.5 | 2 | 1.4 | 1 | 1.6 | 0.6 | 22 | 4 | 2 | 0 | 0 | 0 | ** |
| KK3. Targets with shootback ca | 1 | 2 | 2.0 | 3 | 1.9 | 2 | 1.9 | 0.6 | 22 | 1 | 4 | 1 | 0 | 0 | ** |
| KK4. Real-time casualty assess | 1 | 3 | 1.5 | 2 | 1.8 | 1 | 1.6 | 0.7 | 22 | 3 | 2 | 1 | 0 | 0 | ** |
| KK5. Probability of kill adjus | 1 | 3 | 1.0 | 1 | 1.9 | 1 | 1.8 | 0.7 | 21 | 4 | 1 | 1 | 0 | 0 | ** |
| KK6. Wpn and target pairing da | 2 | 2 | 2.5 | 3 | 2.3 | 3 | 2.2 | 0.5 | 22 | 0 | 4 | 2 | 0 | 0 | * |
| KK7. Wpn and target pairing da | 2 | 3 | 2.5 | 3 | 2.1 | 2 | 2.0 | 0.6 | 22 | 0 | 4 | 2 | 0 | 0 | * |
| KK8. Wpn and target pairing da | 2 | 2 | 2.5 | 3 | 2.0 | 2 | 2.0 | 0.5 | 22 | 0 | 5 | 1 | 0 | 0 | ** |

APPENDIX B

SECTION 4

TABULATED PNS RESULTS
(One vote per organization)

# APPENDIX C

## STRUCTURED FUNCTIONAL ANALYSIS FOR TES

# STRUCTURED FUNCTIONAL ANALYSIS FOR TES

## A. Introduction

Before the technology developments for any force-on-force battlefield TES training system could be determined, it was necessary to define the simulation functions and interfaces needed for TES systems. Once the individual functions which comprised the systems were itemized and understood, then those that must be simulated so as to achieve TES training fidelity, and meet training cost and safety considerations, could be identified. The SFA results showed that many of the simulation functions could be combined and areas for technology development identified.

Though various methods existed for such an analysis, JPL selected Structured Functional Analysis (SFA) as the methodology to use for this effort. This approach had been used in previous Simulation of Area Weapons Effects (SAWE) Best Technological Approach (BTA) studies by JPL.

## B. Background

SFA has been developed and applied extensively as a formal analysis tool for the efficient creation of large interactive computer software programs for data management systems; the intent is to use SFA prior to writing the computer code. Examples are: the Social Security system, banking, major cost accounting programs, and space missions; all of these have many inputs, interfaces and communications. The SFA concept can be applied to any system, and in other formulations SFA has been used for hardware development; JPL further adapted it for the TES analysis.

The significance of using SFA for TES is that the functions or interactions of engagements in combat or training can be determined without any consideration of how they are to be technically accomplished; this prevents selection of the technology prior to defining what functions need to be simulated.

Another advantage of SFA methodology is that it forces the analyst to identify all interactions, tasks and communications used within a system, and minimizes the chance of omitting some portion. It also identifies elements with identical functional requirements so that they may be eliminated or combined, thus reducing or terminating large "tree" structures.

The technique is hierarchic insofar as each element can be further subdivided to obtain more detailed functions. The functions are presented visually as part of a functional diagram, which depicts only a few (6-10) elements.

## C. TES Structured Functional Analysis

SFA was applied to each part of the tactical battlefield system that was to be simulated. It permitted JPL to reduce TES engagements to many specific functional components, and to show the interactions between the components because each function can be scrutinized individually. Those functions that needed to be simulated were identified. However, most actual tactical functions can be used directly in a training exercise. For example, communications between a commander and his tanks need not be simulated, but the function of shooting the tank gun with live ammunition or the function of obtaining a hit and a casualty had to be simulated with the fidelity as defined by the PNS.

Once all the functions that were to be simulated in a particular TES battlefield system had been identified, JPL placed them into one of four categories:

1. The function can be satisfied with current technology.
2. The function requires technology development.
3. The function cannot be satisfied with an identified approach, causing the consideration of other methods.
4. No technical solution can be found for the function.

The many SFA diagrams generated in this part of the TES study were not developed past rough sketches and are not included in this report. The following discussion is an example to illustrate the JPL TES SFA methodology.

## D. TES Diagrams

Figure 1-C is an overview SFA diagram for a Tactical Engagement System, a generalized TES weapon-target interaction. Figure 2-C summarizes the notations used in the TES SFA diagrams. Figures 3-C to 6-C are the SFA diagrams developed for Air Defense.

The two-dimensional symbols (such as rectangles, squares, etc.) identify actual parts of the system, such as hardware, organizations, and troops.

Circles represent TES items that are transparent to the training troops, e.g., the TES casualty assessment calculation system.

The functions that require simulation are identified by diamond-shaped figures (see Figures 1-C through 4-C).

Arrows represent interactions and the communications between the various components. A pairing (double arrowhead line) must exist between the weapon and the target to establish their engagement. The arrows identify required information transfer between the parts. This includes visual, auditory, electronic messages, cues, etc. For example, in the command and control loop, someone gives a mission to the Fire Direction Center for the air defense weapon, which in turn transfers a firing order to the gun crew.

Troops must load ammunition, aim manually or by automatic tracking, and ultimately fire the weapon. Each of these functions requires some communication or "order" to a component of the system.

Cloud-like shapes represent cues. A weapon (block) provides a signature cue (cloud) that may be seen by the troops (rectangles). When a hit occurs, a hit cue must be given for observation by the players. If a casualty occurs, a cue is emitted, and data collected for the event. These cues or signatures are indicated by cloud symbols, but they need not be pyrotechnics.

Those functions which do not exist on the actual battlefield, but are required in the training exercise for data gathering and training exercise control, are indicated by rectangles with rounded corners.

Areas identified as having no TES technology development problems are marked with NTP (no technology problems) and a slash symbol. These areas can be eliminated from further consideration in this study; this has been accomplished as shown in Figure 3-C Air Defense.

## E. Prioritized Needs Summary (PNS) Defined Needs

Each of the PNS technology needs were classified into one of the following categories:

1. Technology development needed.
2. Technology development not needed.
3. Technology development needed, but PNS ranking is too low to pursue (*Priority* or less).

Those needs identified for technology development (category (1)) were integrated into the SFA as functions.

## F. SFA Assumptions

The TES SFA uses the following basic assumptions:

1. The foundation of the TES system is the availability, with acceptable fidelity, of the following information that the maneuvering troops during an exercise must know:
   a. That a particular weapon has been fired, although the actual weapon firing may or may not have been observed (represented on Figure 1-C as the Weapon Signature).
   b. That there is a realistic time-of-flight for the warhead, projectile or missile (represented on Figure 1-C as the Firing Assessment and transmission of data using a transmission media: laser, radio frequency, etc.).

c. That a gunner targeted the weapon on a particular platform, or set of platforms for area weapons (represented on Figure 1-C as the Sensors and Target Volume).

d. That the weapon hit or missed a particular target platform (represented on Figure 1-C as the Hit Cues).

e. That a successful hit on a platform results in appropriate casualty assessment (represented on Figure 1-C as the Casualty Assessment).

f. Players who have become casualties (represented on Figure 1-C as the Casualty Cue) are identified to the other players.

These events occur either naturally during the course of training battlefield actions or need the aid of TES when they cannot otherwise be achieved due to safety or cost.

2. All parts of weapon systems, targets, or any other tactical systems that are used in combat should also be used in a force-on-force field training exercise, and not simulated, unless it becomes necessary because of safety or other restrictions. Thus, only those portions of the actual total combat system that cannot be used in field training exercises should be simulated by TES.

   This approach provides maximum realism and fidelity in the force-on-force training exercise. In general, only the lethal components of live weapon systems, such as live rounds, mines, and chemical weapons require simulation. Any function or result of live firing must be simulated. This includes a weapon firing signature (such as smoke, bang and flash) and casualty-associated functions (such as a round hitting a target, casualties, etc.).

3. A factor of increasing importance is cost. There are training functions that are candidates for simulation simply because of the high cost of doing the real thing. Tank main gun and especially ATGM firings, even with the safety of live fire ranges, are prime examples.

4. A second category of functions, those that do not exist in the real battlefield environment, are also necessary for effective training. These functions relate to the control and administration of the exercise itself, such as data acquisition, casualty assessment and counting, scoring, and augmented feedback during training. Most of this data can also be used in the After Action Review (AAR), which should occur within 1-2 hours after the engagement portion of the exercise is completed.

5. The Multiple Integrated Laser Engagement System (MILES) is the baseline technology because MILES is now evolutionary and will continue to be used by the Army for at least the next decade.

6. Cues of engagement, such as weapon firing, target hit, and casualty effects do not have to match the real events; however, they must

impart the information that is available on the battlefield with the same probability of detection and timing.

G. SFA Results

A TES SFA diagram was drawn for each weapon system associated with the technology needs rated *"Highest"* or *"High"* priority. Many of these diagrams were so similar that the TES functions could be combined into nine categories of technology development problems:

1. The TES Instrumented Platform
2. Smart Weapons
3. Simulated Gunnery
4. Air Defense
5. Artillery and Mortars
6. FASCAM
7. MOUT
8. Command and Control of the Training Exercise
9. Obscurants

Other PNS items having *"Highest"* or *"High"* priority ratings were included in the above categories:

Types of Weapons
Artillery and Mortar Effects
Casualty assessment
Cheating
Combat support
Embedding of training aids
Interoperability
Intervisibility
Live Fire Exercise Targets
Signatures (weapon firing and hit or casualty cues).

PNS items for which JPL has concluded that technology development is not needed are:

Attrition
Communications Disruption
Controllers
Nuclear, Biological and Chemical
OPFOR

JPL also concluded that some of the PNS items were not technology dependent since performance improvement can be achieved simply from the application of good engineering in the design phase. These are:

Type of Training
Location of Training
Unit size
Size of TES Equipment
Weight of TES Equipment
Type of Electrical Power
Built-In Test (BITE)
Installation of TES Equipment

Some PNS items are not dependent on technology, but on administrative issues and Army doctrine or policy:

Issue of TES Equipment.
Maintenance of TES Equipment.
TES Equipment Training.

## H. Overall TES System Weapon Target Interactions

During the course of conducting the SFA it became apparent that:

1. It was not necessary to duplicate and consider functions for TES technology development for both the Blue and Red or OPFOR. All that is necessary to determine the first order functions is consideration of a weapon system and a target. An entire TES engagement, in which opposing forces conduct their respective missions, can be generalized as the collection or linear summation of each of the individual weapon firing and target interactions.

2. The current TES system (MILES) and any Future TES system (the subject of this study) can be functionally represented at any instant in time simply as a weapon being fired at a target, with the TES system superimposed on the events which could occur during this singular engagement event.

## I. Air Defense SFA Diagram Summary

The air defense SFA diagrams, Figures 3-C through 6- C, indicate the interactions and relationships between the real and simulation elements. It is intended that they represent all of the functions needed, independent of any particular weapon or target; this should lead to an integrated TES technology that is essentially weapon independent from current or future weapons or targets. Thus, Stinger does not need all of the elements, but a radar-controlled Vulcan system does.

It is important to note that the essential elements of this air defense TES system are concentrated in the diamond titled "Warhead Delivery Simulation" of Figure 4-C.

Review of the functional diagrams results in a list of hard-to-do functions for any air defense system and its target; these are shown in Table 1.

From these functions, one or more technical approaches which could satisfy the functions are developed. These are listed in Table 2.

## J. Air Defense Technology Summary

From the PNS and SFA, a TES technology development problem summary statement was made for air defense.

The overall conclusion from PNS data is that the Army wants essentially the same level of capability for air defense (AD) as for tank gunnery. Simulation of engagements with low performance aircraft was given higher rating than that with the fast movers. Identification of Friend or Foe (IFF) is to be played. Interestingly, the Army wants to simulate incoming attacking targets, but do not want to use remote piloted vehicles (RPVs) as part of simulation.

A most significant technical problem is to provide for target lead; however, if the combat system calculates lead automatically, then a laser pointed at the target at the time of trigger pull may be adequate for TES.

## K. Technology Development Problems for Air Defense from the SFA

Many of the air defense simulation issues are the same as those for simulated tank gunnery, including use of fire control system functions in the simulation. Study of the SFA indicates that laser-based direct fire simulation system technology can be used to satisfy most of the requirements. Additional problems for air defense are:

1. The wide view angle of target acquisition systems may require the use of scanning lasers.

2. The operating range of air defense weapon systems will tax the capabilities of eye-safe lasers.

3. Instrumentation mounted on aircraft must pass rigorous air-worthiness acceptance procedures.

Air defense missiles (Redeye, Stinger) simulation should be integrated with the simulation for antitank missiles as the technology development issues are similar.

## Major Air Defense TES Functions

- Air Defense Weapon Functions
  - Warhead delivery simulation
  - Weapon parameters
    - Warhead delivery & effects signals
    - Weapon signature
  - Receive feedback signal from target
  - Target identifications
- Air Defense Target Functions
  - Warhead delivery sensors
  - Fuzing data
    - Target status data
    - Position, altitude and velocity vector (speed)
  - Countermeasures in use
    - Evasive maneuvers
  - Feedback signal to weapon
    - Casualty signature (not a technology problem if a flashing light, visible to all players, is sufficient.)
  - Casualty data to TES instrumentation

Notes:

1. There are three categories of aircraft targets: high speed fixed-wing, low speed fixed-wing, and rotary.
2. There are three categories of air defense weapons: radar (Vulcan), infrared (Stinger and Red Eye), and small arms (M16 rifle).

Table 2. Laser-Based Derived Technical Approaches

- Aiming of weapon is accomplished in the usual way: either optically or automatically by gun controller fed by radar.
- Loading:

  Gun crew loads missile on launcher, or
  Gun crew does not load shells into gun (automatic).

- Selected type of missile or ammunition is input into warhead parameters computation.
- Warhead parameters, gun/launcher attitude, and fire signal are input to Warhead Delivery Simulation.
- Warhead Delivery Simulation activates the Weapon Signature simulation which is seen by troops.
- Warhead Delivery Simulation:

  For Gun, send Laser pulse coded with gun and shell type for each shot.
  Gun controller and Delivery Simulation together account for lead, *etc.*

- Laser beam is received at target by:

  Reflectors that modulate the incident signal to indicate identification of target to weapon.
  Sensors that detect the weapon delivery signal.

- Casualty Assessment:

  Determines from the beam whether it was a hit (and what type of hit) or a near-miss.
  Uses stored count of hits (or prior damage) and type of warhead to determine type of casualty.
  Activates casualty signature.
  Passes pairing and casualty information to TES data and feedback functions.

- Casualty Signature gives one signal to aircraft crew (example: buzzer or flashing light inside aircraft) and another signal to others (example: flashing light or pyro smoke grenade).
- Feedback function sends list/near-miss signal with aircraft identification to attacking weapon.

  Laser beam is reflected back to air defense weapon.
  Flashing light with coded information is picked up by weapon.
  Low power RF radio signal is sent to weapon, etc.

## L. Air Defense Ground Rules

In conducting the SFA, assumptions, questions, ground rules, notes, etc., were generated; these are summarized below.

1. Air defense does not have an obscurant problem. However, for air defense thermal sights, the technology problem and technical solution are the same as for tank gunnery.

2. When a sight is aligned with target and fired, the gunner has done all he needs to do for a hit. The path, etc., are determined by weapon ballistics. Thus, lead is computed by the weapon system or TES system.

3. Identification Friend or Foe (IFF) systems need not be part of TES since the real IFF systems can be used. The Army has a problem concerning the use of weapons, such as Stinger, in how their operation can be controlled to prevent fratricide. This is beyond the scope of the TES operation except to provide the appropriate data that it has occurred.

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Yourdon, Edward, and Constantine, Larry L., *Structured Design*, Yourdon Press, New York, NY, 1978.

# Tactical Engagement Simulation

## Overall Interaction Diagram

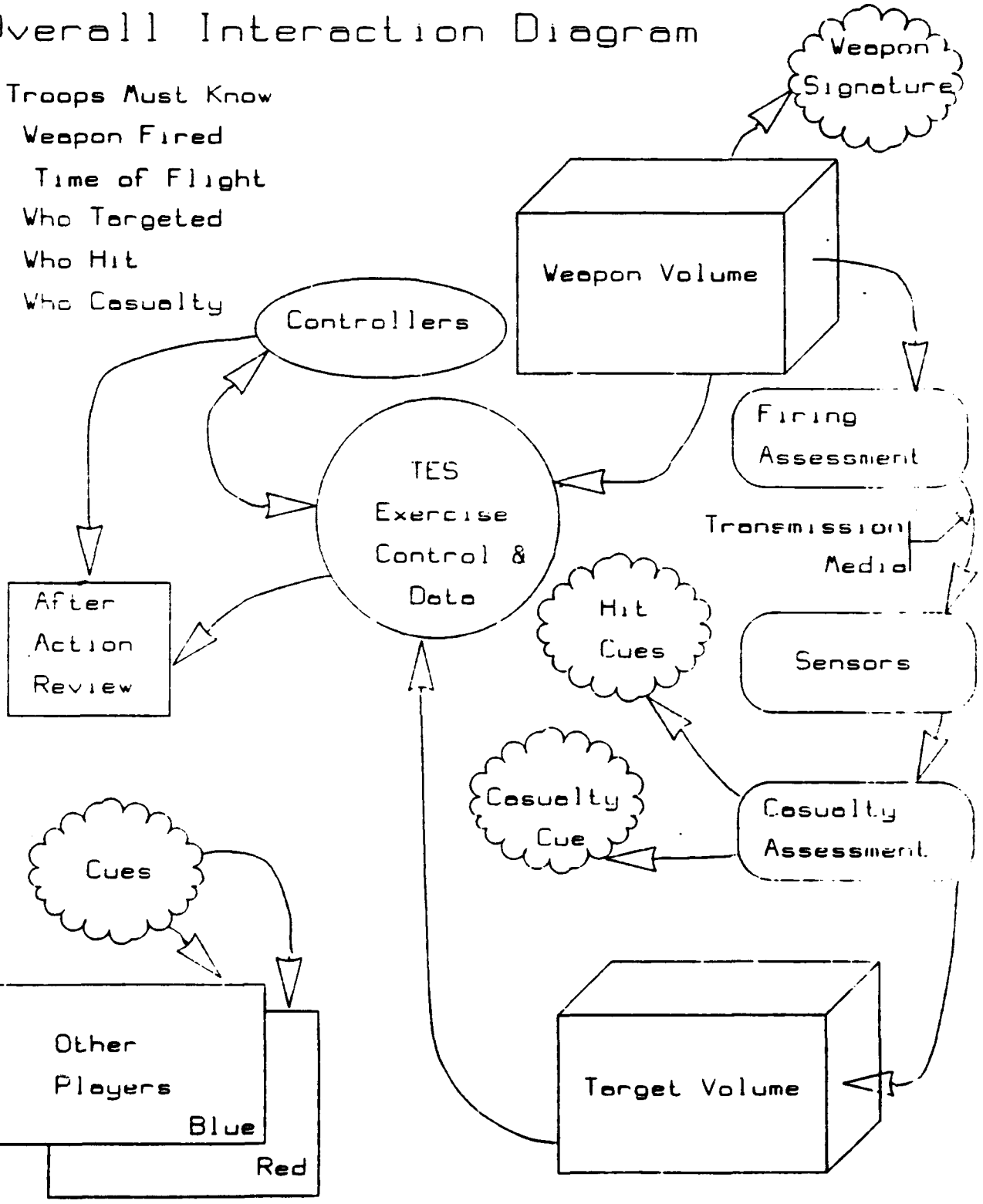



FIGURE 1-C

# NOTATION FOR TES DIAGRAMS

Structured Functional Analysis Interaction Diagrams

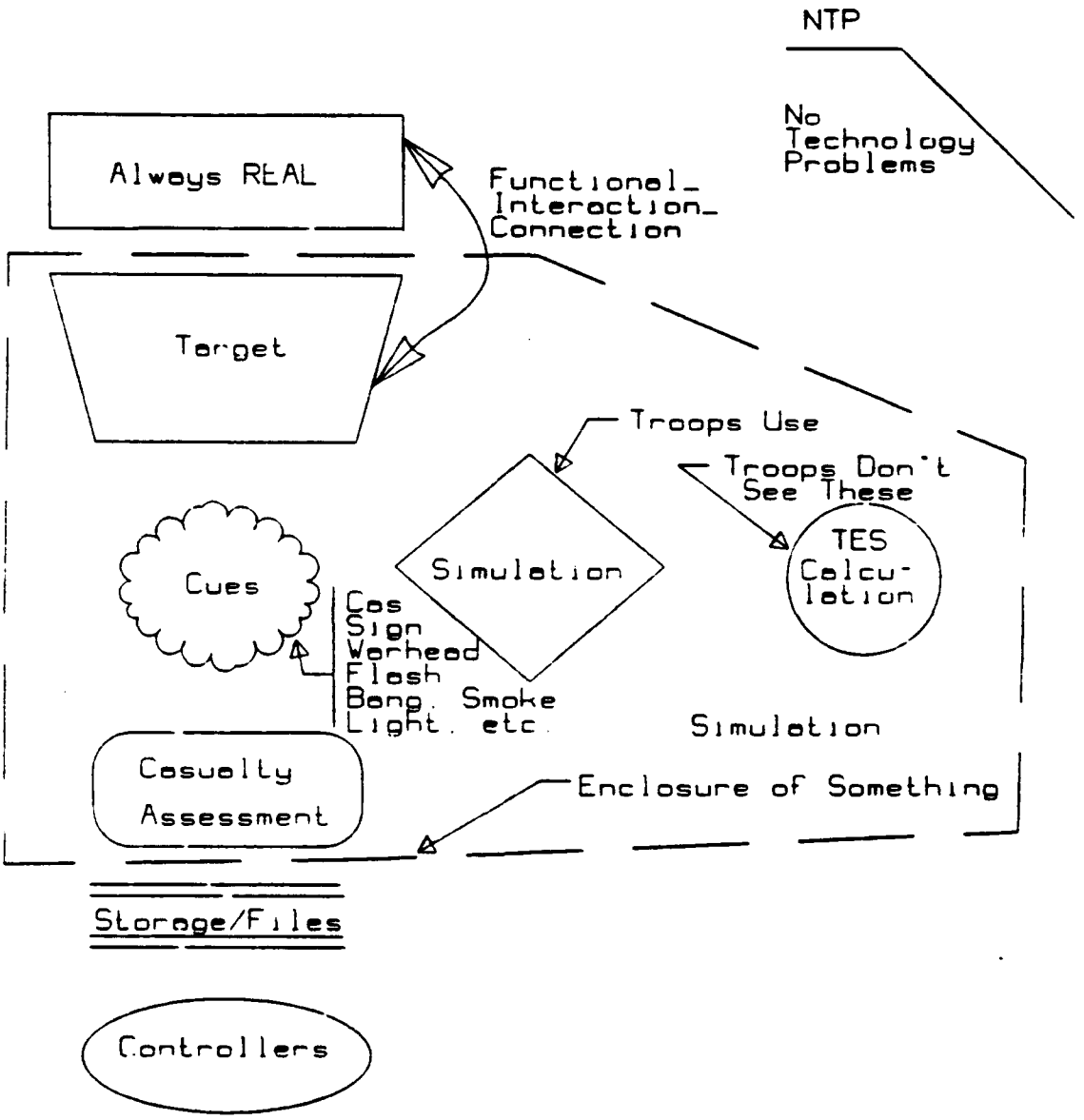



FIGURE 2-C

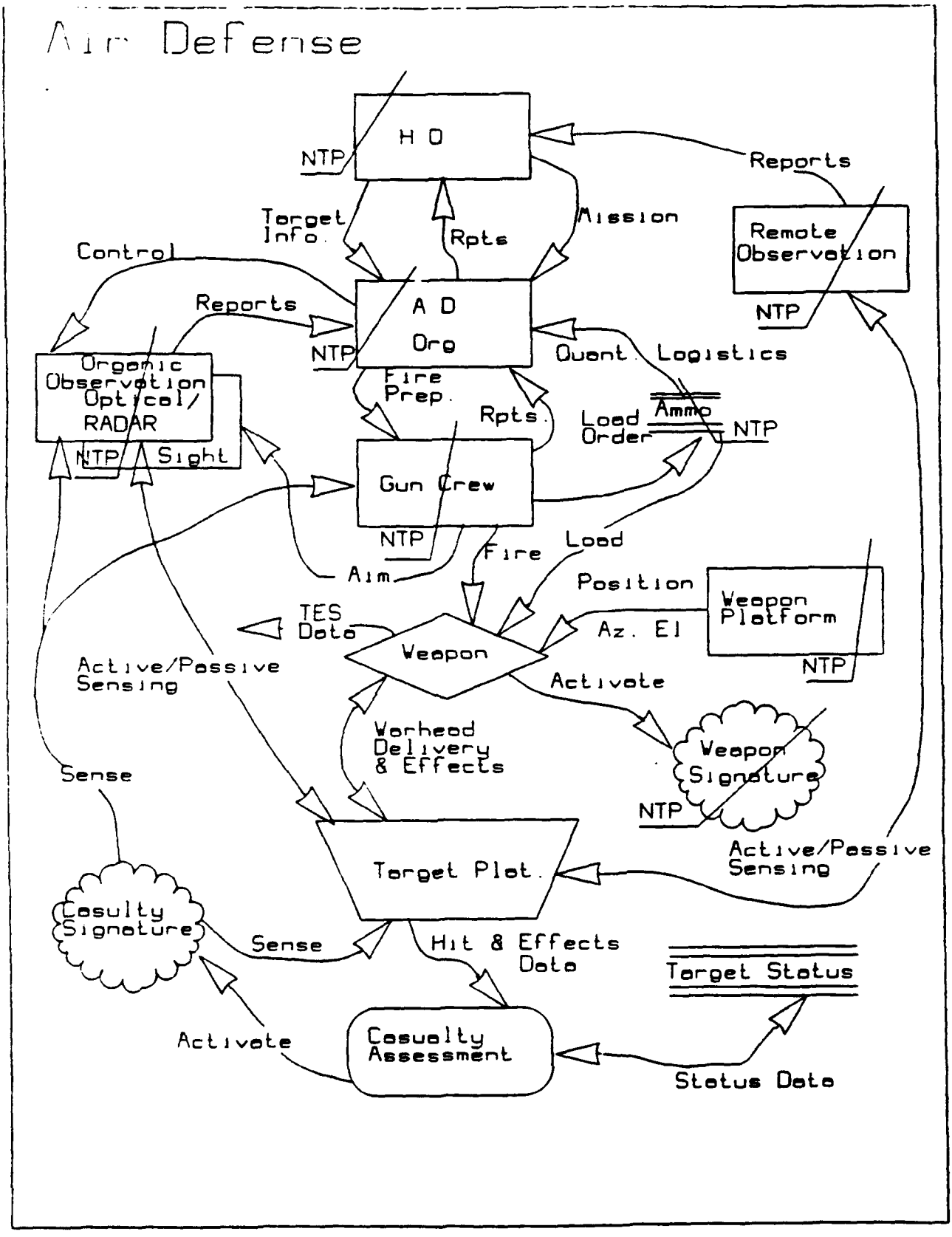

Air Defense
H O
NTP
Reports
Target Info.
Rpts
Mission
Remote Observation
NTP
Control
A D Org
Reports
NTP
Quant. Logistics
Organic Observation Optical/ RADAR
NTP
Sight
Fire Prep.
Rpts.
Ammo
Load Order
NTP
Gun Crew
NTP
Fire
Load
Aim
Position
Weapon Platform
NTP
TES Data
Az. El
Weapon
Active/Passive Sensing
Activate
Warhead Delivery & Effects
Weapon Signature
NTP
Sense
Active/Passive Sensing
Target Plot
Casualty Signature
Sense
Hit & Effects Data
Target Status
Activate
Casualty Assessment
Status Data

FIGURE 3-C

# Air Defense. Weapon

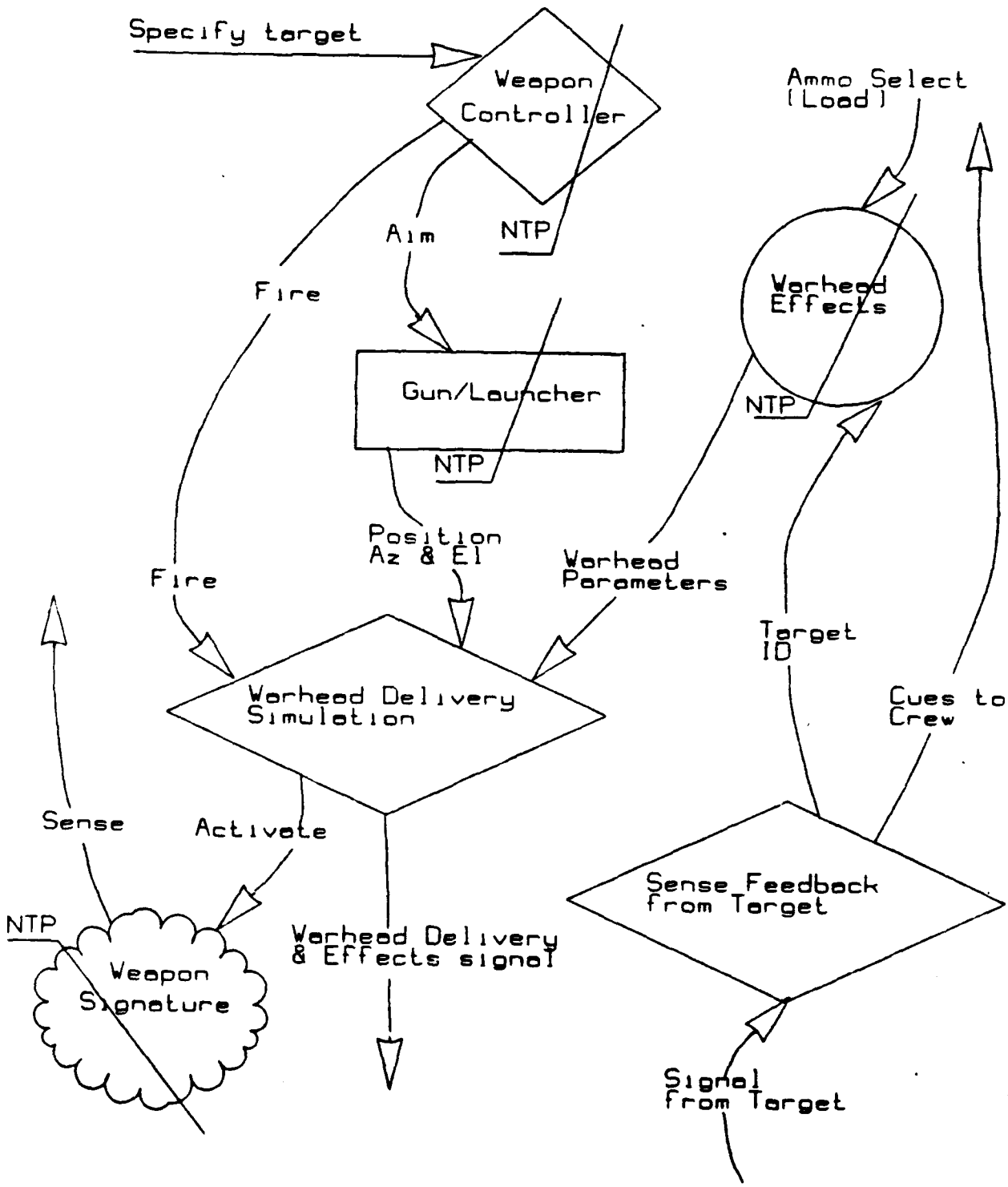



FIGURE 4-C

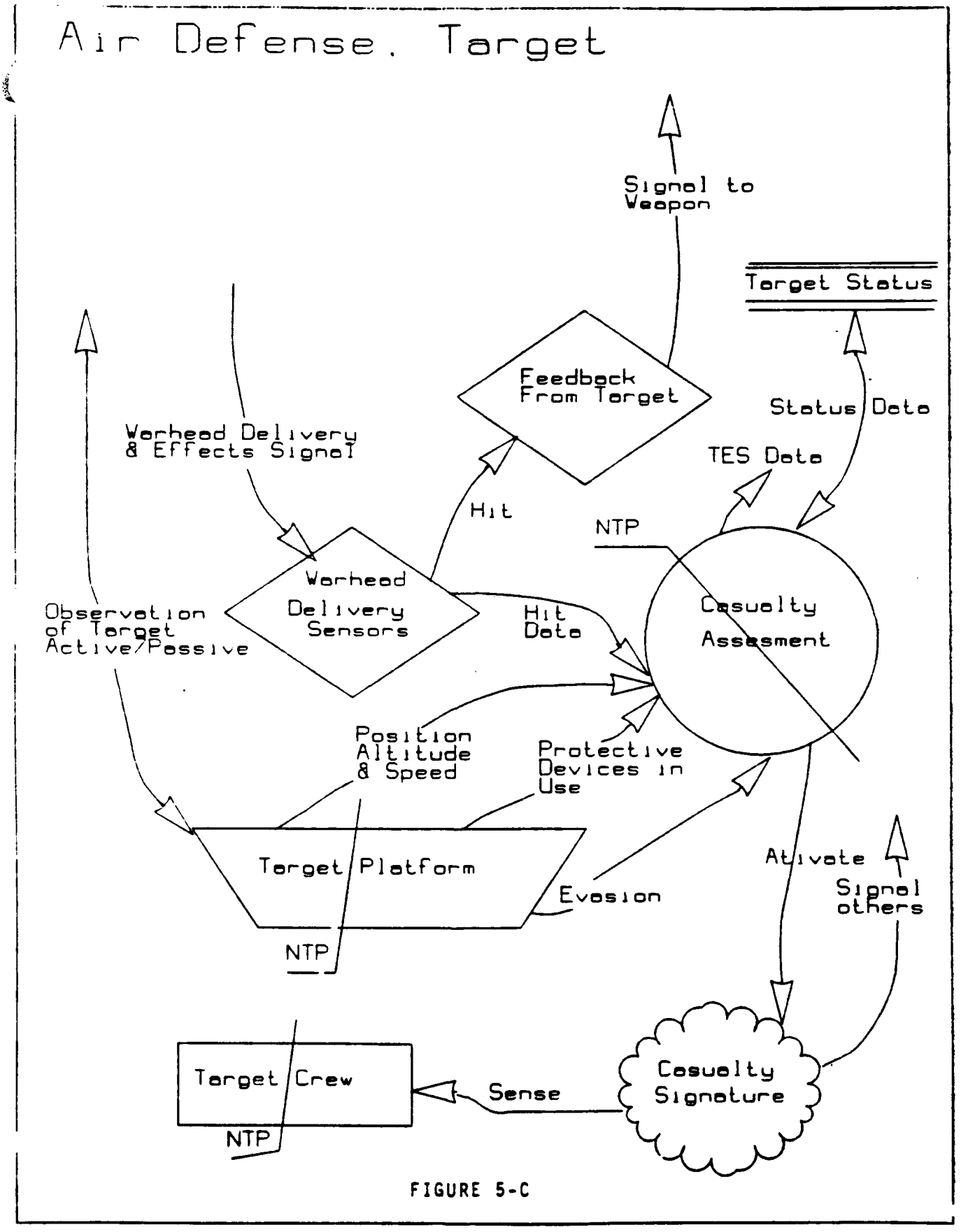

Air Defense. Target
Signal to Weapon
Target Status
Feedback From Target
Status Data
Warhead Delivery & Effects Signal
TES Data
Hit
NTP
Warhead Delivery Sensors
Casualty Assesment
Hit Data
Observation of Target Active/Passive
Position Altitude & Speed
Protective Devices in Use
Target Platform
Evasion
Activate Signal others
NTP
Target Crew
Sense
Casualty Signature
NTP

FIGURE 5-C

# Air Defense Reduced

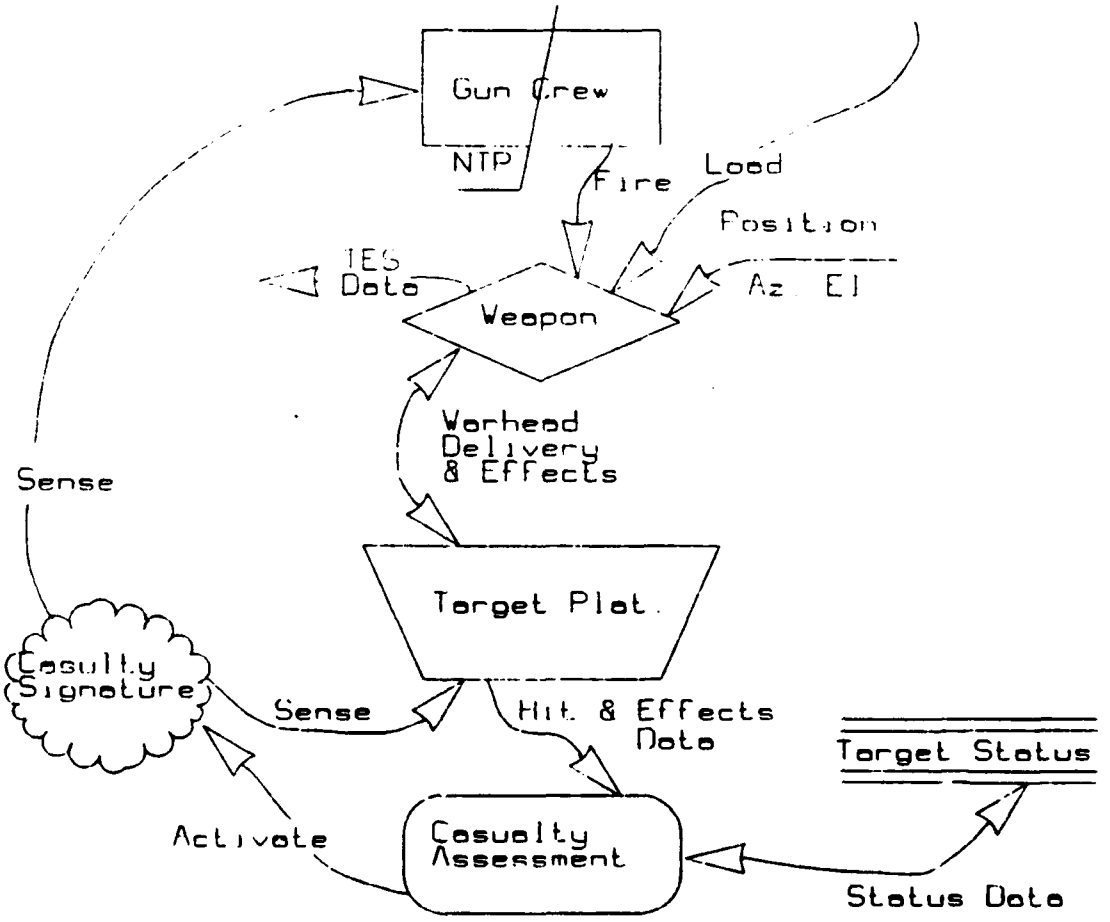



FIGURE 6-C

# APPENDIX D

## TES TECHNOLOGY


| | | |
|---|---|---|
| Section 1 | Overview | D-1 |
| Section 2 | TES Technology Development Prioritization | D-14 |
| Section 3 | JPL Areas for TES Technology Development | D-29 |
| Section 4 | Workshop Report | D-77 |
| Section 5 | Minutes of the Future Generation TES System Meeting | D-148 |

# SECTION 1

# OVERVIEW

## I. Technology Development Priorities

After cataloging the PNS Questionnaire responses, the next JPL task was to evaluate the issues and features which had sufficient support across all Army elements for JPL to justify the effort to assess the availability of technologies to support the next generation of TES. Since the average Army priority rating represented a consensus of the wishes of units with different missions, the averages had to denote which features were desired unanimously and which represented a split opinion. Keeping in mind that there will naturally be many constraints on funding for Army training, JPL judged that only those features that were sought nearly unanimously by the Army could be included and developed in the designated time frame for the next generation of TES. Thus, a further evaluation that showed the highest priority features based on the Army user ratings was required.

Using the numerical rating for each TES feature (obtained from the responses to the PNS Questionnaire), JPL assigned a new set of ratings that would apply to the priority for assessing the availability of supporting technologies to each issue:

| Numerical Rating from Questionnaire | JPL Priority for Assessing Supporting Technologies |
|---|---|
| Less than 1.5 | Highest |
| Between 1.50 < 2.00 | High |
| Between 2.01 < 2.50 | Priority |
| Greater than 2.51 | None |
| Greater than 3.5 | Possible Negative Training |

Ratings averaging between 1.0 - 1.50 were given a ranking of *Highest*. Thus the *Highest* rating was given only to those items in the questionnaire to which more than half of the Army organizations gave a rating of "Mandatory (1)". Then, those with a rating between 1.50 - 2.00 were given the next highest ranking, *High*. Ratings with average values above 2.00 were judged not to have enough priority within the Army to be considered further by JPL for recommended technology development programs. Although no technology development programs were recommended to specifically support TES issues with priorities less than *High*, it can be assumed that many, if not all, of these lower priority needs will benefit from the generally broad programs which are recommended. The resulting JPL recommendations are presented in Section 2 of this appendix.

A complete discussion of the technology issues, along with supporting justification for the prioritization, is included in this appendix as Section 3.

Using Structured Functional Analysis (see Appendix C), JPL has combined the features of the *Highest* and *High* items into nine categories of future generation TES on which technology will have critical impact:

1. The Instrumented Platform
2. Smart Weapons
3. Simulated Gunnery
4. Air Defense (Counter Air)
5. Artillery and Mortars
6. FASCAM
7. MOUT
8. Command and Control
9. Obscurants

1. The Instrumented Platform

The following PNS topics have been grouped into the single category Instrumented Platform:

a. Live Targets
b. Intervisibility
c. Cheating
d. Interoperability
e. Casualty Assessment
f. Embedding.

Note: These topics have been combined because the Structural Functional Analysis (SFA) showed that they are all related in some way to the target platform. JPL considers TES engagements to be between instrumented platforms; i.e., a soldier is a platform for a rifle, a dismounted TOW launcher together with its crew is considered to be a platform, a tank is a platform for the tank main gun and .50 cal machine gun. A Combat Service Support (CSS) truck moving supplies is considered a soft target, and when instrumented with a PDD it also becomes a platform, even though it has no weapon.

Technology development problems for the Instrumented Platform include:

a. Live Fire Targets and Intervisibility. For live fire exercises, the targets need to be able to shoot back so that simulation of return fire under battle conditions can be obtained. JPL interprets this to mean: lack of certain actions by armor crew on the live fire range will be "punished" with being targeted by the shoot back simulation. Of course, personnel cannot be used at the targets for both safety and manpower reasons. The target needs to detect the presence of opposing weapons (intervisibility) and to fire back remotely (pairing is accomplished). It will probably be necessary to provide for real-time casualty assessment on the trainee platform and for the shoot back effect to be realistic and believable so that troops react properly, for example, fire their weapons as if they could become targets.

b. Cheating. Cheating is nearly impossible to prevent; however, it needs to be detected and indicated (the indication is easy to

accomplish). The problem is to know with very high reliability that cheating has actually occurred, instead of it being some equipment malfunction or even a TES system operational deficiency.

c. Interoperability. New TES systems need to be compatible with existing major engagement simulation and training systems in the Army inventory, such as MILES and TWGSS, as well as accommodate future weapon developments. A single programmable module, such as a Player Detector Device (PDD), that can be used on any target would be desirable.

There are several approaches to the weapon-target simulation interaction, but the Army, in implementing MILES, made a major decision: the target and weapon players shall each carry a significant portion of the direct fire weapon simulation system. JPL does not propose to change that decision for TES, based on the need to interface with MILES in the future. JPL assumes that a proper direction for TES is to maintain the same approach, but to add an improved device (a PDD) with more capability than MILES provides, to the target platform.

d. Casualty Assessment. Future TES systems should have the capability to assess moblity kills on vehicular platforms. MILES does not have this capability. To obtain the necessary casualty effects, the tendency is to cause the simulation system to maximize the casualty; tracked vehicles now can have only a catastrophic kill effected by a simulated mine, instead of the option for a platform mobility kill. The rationale is that it should make little difference because a motionless platform will be destroyed almost immediately. Artillery casualty effects have the same limitation for track damage. This approach in the future can distort the TES simulation into becoming unrealistic.

There will be a need to provide realistic damage assessment and repair cues for Combat Service platforms. This is similar to the requirement to operate in degraded modes. Damage assessment could be integrated with the attrition of combat vehicle crews and NBC medical play where casualty cards are being used in present day exercises. There may be enough real repair work in training exercises to keep the CS and CSS troops busy.

There is a need for near-miss cues in future systems. MILES provides this for the dismounted soldier. When the cue is electronic (buzzer sounding) there is no technology development problem; however, when the cue simulates a round bursting, additional technology is needed. Such cues are as useful and needed for the adjacent players as for the targeted player. Another problem is providing realistic cues for near-misses which are 400-500 meters or more away from the intended target, such as off-target artillery. Relatively expensive and sophisticated systems such as the SAWE Indirect Fire Simulation launcher and projectile seem to be the only practical approach.

e. Embedding. TES training capability can be embedded within the weapon or target. This is certainly a controversial philisophical issue within the Army despite the fact that having training equipment embedded is now official doctrine. If we accept the PNS results which rank tank and helicopter weapon systems as the only two weapon platforms that need embedded training devices, then we may not have a technology development issue. Both have sufficient system sophistication to easily include additional embedded simulation technology, especially in control system software. However, because embedding is official Army procurement policy, the Army should define just what is to be included or not included in embedding training--is it software, hardware, throwing switches, quick changeout of boxes, etc.

It is more important to embed instrumentation in the TES system than to embed TES in the weapon system. The disadvantages to embedding TES in the weapon are: the more it's embedded, the less it's adaptable (to upgrades or other weapons); if you change the weapon, you must change the simulator; if the simulator is down for repair, the weapon is also down; TES is not useful early-on for developing the weapon.

2. Smart Weapons

The following PNS topics have been grouped into the single category of Smart Weapons:

a. Target Aquisition
b. Aiming
c. Tracking
d. Firing
e. Target Area Effects
f. Real-Time Casualty Assessment

Weapons include rocket artillery and guided missiles used against armor and air.

Technology development problems for Smart Weapons include:

a. Target Aquisition, Aiming and Tracking, and Firing. The simulation of missile guidance, when an optical or television image of the target and real terrain is presented to the gunner, will be a challenging problem. If the image can be low resolution, then the problem will be less. In force-on-force exercises, the targets presented must represent the actual available opposing force targets. Simulation of weapon firing might be simulated with existing technology.

b. Target Area Effects and Real-Time Casualty Assessment. The simulation of cues for incoming missiles is needed for all missile weapons when targets would be able to determine that they are under attack and should take evasive action. Missile flight also may be observed by adjacent platforms which then direct that action be

taken by the target. For example, a heat-seeking missile not seen by the target might be observed by adjacent platforms.

3. Simulated Gunnery

The following PNS topics have been grouped into the single category of Simulated Gunnery:

a. Simulated Gunnery
b. Tank/Fighting Vehicle Systems
c. Directed Energy
d. Signatures and Cues

Technology development problems for Simulated Gunnery include:

a. Precision Gunnery. Current and projected technology precision gunnery simulators such as TWGSS, Simfire, Saab, and Tallisi are available for TES. However, these systems are expensive -- as much as ten times the cost of MILES. JPL assumes that the Army cannot provide sufficient sets of TWGSS-like systems for their maneuver engagement training. Thus, what is needed is a TES approach that will significantly decrease the cost. The following are the functions that are hard to do:

1. Inclusion of the fire control system for aquiring moving targets and shoot-on-the-move;

2. Accurate simulation of weapon warhead effects on the target hit zone;

3. Presentation of burst-on-target to the gunner
;

4. Pairing in obscurants and light cover;

5. Gunnery in degraded modes;

6. Interfaces with other engagement systems.

The Army needs to define the requirements for TES gunnery realistically so that some increased capability over MILES may be implemented at reasonable cost. Other considerations are: will these systems be used only at instrumented ranges and does the OPFOR need to have the same capability.

b. Signatures. Signatures are placed within this category because it is assumed that the signature and cue technology developed for tank gunnery would be applicable to other weapon systems.

c. Directed Energy. The issue with directed energy weapons is how to interface the simulation system--laser technology will work--with the optics of the target weapons systems. The technical problems are the same as with precision gunnery in interfacing with the sight.

4. Air Defense

Technology development problems for Air Defense include:

Many of the air defense simulation issues are the same as those for simulated gunnery, including use of fire control system functions in the simulation. Structured functional analysis of air defense TES indicates that laser-based direct fire simulation system technology can be used to satisfy most of the requirements. Additional problems for air defense are:

a. The wide view angle of target aquisition systems may require the use of scanning lasers.

b. The operating range of AD weapon systems will tax the capabilities of eye-safe lasers.

c. Instrumentation mounted on aircraft must pass rigorous air-worthiness acceptance procedures.

Air defense missile (Redeye, Stinger) simulation should be integrated with that for antitank missiles; the technology development issues are similar.

5. Artillery and Mortars

The following PNS topics have been grouped into the single category of Simulated Gunnery:

a. Artillery and Mortars
b. Artillery and Mortar Effects
c. Grenade Launcher

Technology development problems for Artillery and Mortars include:

a. Suppressive Fires. There is a need for future TES systems to provide a means of simulating the effects of long duration (one hour) artillery prep or other suppressive artillery fire at low cost. It is important to produce some of the psychological effects of massive suppressive artillery fires.

b. Shell Burst Cues. The Army currently cannot make a decision on what shell burst cues are needed at the National Training Center (NTC), Ft. Irwin, California. One group within the Army believes that realistic incoming artillery cues are not economically justified or that such cues are not necessary for maneuver exercises; other Army groups do not agree. The PNS results indicate that artillery round burst and near miss cues are needed. Shell burst cues need to be delivered to the target area with a degree of safety appropriate for training. Hand-thrown pyrotechnic flash, bang and smoke cues have been the approach in the past; however, they lack surprise and realistic timing. In addition to cues for troops in the target area, ground burst cues for the Forward Observer (FO) are needed to provide for realistic adjustment of fire.

c. Grenade Launchers. The problem is providing target area cues and methods for casualty assessment in an indirect fire mode without having any material dropped onto troops. This problem occurs when the grenade launcher is fired from or onto targets in defilade; if fired direct, then a laser engagement system can be used. The conclusion is that most current technology options are not applicable if one cannot drop something on top of troops because of safety. The problem is compounded by the requirement to keep simulated rounds cheap and expendable as well as safe. It is important to integrate the grenade launcher technology with artillery, mortars and FASCAM because the development problems are similar.

6. Family of Scatterable Mines (FASCAM)

JPL now feels that there are significant differences between the TES needs for conventional mines and for FASCAM. This distinction was unfortunately not made in the preparation of the PNS questionnaire. The requirements for simulation of conventional mines can be adequately met with the technology currently used in the SAWE Mine Effects Simulator (MES) system. Significant problems remain in the simulation of FASCAM.

Technology development problems for FASCAM include:

a. Deployment. FASCAM involves the rapid deployment at high density of small antitank (AT) and antipersonnel (AP) scatterable mines from remote sources (or simulated remote sources) by artillery, helicopters, or ground vehicles. A persistent question is whether each indivdual mine must be simulated, or if it is sufficient to only simulate the overall effects of the minefield.

b. Automatic Arming and Disarming. Deployment of FASCAM includes the automatic or commanded arming and disarming of the mines or time-delayed destruction; note that the time delay may or may not need to be the same as the several hours or days for the real mine, and the mechanism does not have to be a duplicate of the real device.

c. Encounter. Again there is the question of one-for-one mine simulation or just the overall effects, cues and casualties, of the entire field.

d. Breaching. There is a need for the simulation of the effects of FASCAM mine destruction when breaching a path (vehicle or personnel) through the minefield. It may not be technically feasible to combine all the functions together within an individual mine simulation replica. JPL concludes that technology development is needed. JPL also concludes that the Army cannot afford to implement a one-for-one FASCAM replica mine simulation, and that it is not necessary for the simulation to have all of the simulation functions within a replica device.

7. Mission Operations in Urban Terrain (MOUT)

Technology development problems for MOUT include:

TES Simulation of MOUT has the limited weapon set of dismounted troops (although armored and artillery troops could also participate, in which case these additional weapons would need to be integrated into MOUT) and can be divided into four approaches:

a. Improve the MILES-type system so that it can perform the MOUT functions.

b. Add additional devices or equipment to the MILES-type system so that the weapons and targets can be used in the MOUT exercise.

c. Provide a TES system used for only MOUT exercises.

d. Provide a TES system that could perform both MOUT and field functions.

The fourth approach presents the greatest technology development problem. It is not clear what the most cost effective approach would be, because the number of MOUT exercises are only a small fraction of the overall number of TES exercises. Probably the main reason for this is the lack of adequate training sites for MOUT. The hard-to-do functions are:

a. Casualty assessment inside buildings.

b. Engagement in close combat.

c. Cues and signatures in close combat.

d. Simulated destruction of protective cover.

8. Command and Control

Technology development problems for Command & Control:

The primary problem is the storage, analysis, and management of massive amounts of data during the training exercise, in particular that which will be used in real time for the After Action Review. This problem is compounded when the TES system is used on a range that is not instrumented like NTC.

9. Obscurants

Obscurants are normally considered to be miliary smokes; in particular, fog oil-generated aerosols used in force-on-force maneuver training exercises. However, because the simulation technology development problems are the same, JPL also considers the following to be obscurants: soft cover (foliage, canvas, tenting, camouflage netting, etc.); weather (fog, haze, rain and snow);

dust; and smoke from diesel oil or simulation fires. It is not necessary, but would be desirable, to have a single technical solution for the obscurants.

Technology development problems for Obscurants include:

a. Cover. Technology development is needed for TES simulation of direct fire through soft cover (light foliage, tenting, camouflage material, etc.) because laser-based simulation systems like MILES cannot simulate the penetration of this type of cover to obtain pairing. Radio frequency systems used alone do not have the narrow beam width required for realistic hit fidelity. This technology development could also relate to interoperability and intervisibility needs.

b. Smoke and Dust. The Army currently is actively trying to solve the obscurant MILES pairing problem for NTC exercises. There are several technical approaches which can potentially solve the problem: carbon dioxide laser, erbium glass laser, millimeter wave phased array, and K-band police radar. JPL has reviewed these technical approaches and recommended a hybrid system using both a laser and radio transmissions to obtain the pairing. This approach will probably provide pairing through fog oil smoke and perhaps the dust at NTC; however, it does not address the soft cover need.

c. Other. During a discussion at TCATA, Ft. Hood, Texas, it was reported to JPL that reliable pairing is not being obtained during their test exercises with laser-based systems. The reason for this was not known. In test equipment calibrations the results indicated 80 to 90% pairing occurred. When armored troops were in defensive (fixed) position exercises pairing was only about 60%; with armored troops in the offensive, pairing was only about 40%, where video data showed targets were properly engaged but hits were not obtained. This anomaly certainly needs to be investigated for its impact on future laser-based engagement systems.

10. Other Issues

Issues listed in the Army Statement of Work (see Appendix F), but not included in the JPL list of nine technology development problems:

1. Increased reliability. This is not a technology issue; increased reliability can be achieved through system design improvements.

2 Increased maintainabilty. This is not a technology issue; better maintainability can be achieved through system design improvements.

3. Longer exercise duration expectancy. This is basically a trade off in battery size and type. Current acceptance in the use of lithium batteries offers the potential of major increases in operating time.

4. Incorporation of tactical engagement simulation function into a single data processor. The current approach to a single, integrated Player Detector Device (PDD) is the answer to this issue.

5. Increased kill code capacity of system. The capability to do this exists today, it is not a technology issue.

6. Display of the type and severity of wounds. This issue received a low priority response from the Army to the PNS Questionnaire. It was therefore not considered further by JPL.

7. Increase capability to automatically assess battle damage on vehicles (degraded performance - weapons, mobility, communciations). The capability to do this exists today, it is not a technology issue.

8. Compatability/interfaces with current and planned NATO systems, CDEC, TCATA, and the NTC. This is a political issue that will not be solved by technology alone. It seems very unlikely that the parties involved will be able to agree on standards for TES system interoperation. Some European systems are not even compatible with themselves (Simfire, for example).

## II. Assessment of Available Technologies

After the highest priority features had been determined, it was necessary to identify disciplines and technologies that would impact each of these individual features and assess the status of each one. Some would be mature enough to be immediately applicable to today's needs. An example is the application of eye-safe $CO_2$ lasers to the problem of pairing through obscuration. Currently available commercial $CO_2$ lasers appear to be usable in engagement pairing systems with only minor modifications such as some packaging redesign to meet the rigors of Army field use.

Other technologies have the potential to solve problems in the design of future TES systems, but have not yet reached a state of maturity where they can be immediately applied to TES designs. An example is millimeter-wave (MMW) radar which has promise as a solution to the problem of pairing through obscuration. A study by the Army's Harry Diamond Laboratory investigated just such an application. But current MMW hardware is too large, too fragile, and too expensive to be practical for TES field systems. The further development of this technology, which is being heavily financed by the weapons and avionics industries, and others, promises vast improvements to the state of the art, and may provide a viable solution to pairing through obscuration in the near future. Therefore, it will be prudent for the Army training community, if not to fund such development, at least to monitor its progress and step in with conceptual demonstration programs when the time is right for TES applications.

To assist JPL in identifying and assessing the current state of technologies applicable to TES, a Technology Workshop was held at Cal Tech in April, 1987. The purpose of this workshop was twofold:

1. To suggest new technological approaches that might be used to solve specific problem issues for future generation TES.

2. To identify new technologies that are not yet mature but that should be developed by the Army to ensure the success of future generation TES systems.

The workshop panel met for two days. Because of the brevity of the meeting, the two days served mainly as an orientation session to present the future needs of TES and the technological problem areas encountered by JPL in designing the next generation of TES. Discussions concerned the subjects of hand grenade simulators, use of MILES in obscurants, command and control of exercises, improved simulation of ballistic gunnery, addition of air-ground operations to TES, and new TES technologies. However, the most creative suggestions were submitted by the panel members after they returned home from the meeting. Subjects covered were: new technologies for TES applications, MILES in obscurants, exploitation of software for simulation, motivation and stress in simulation, scaling, and engagement simulation for joint air/ground operations. These topics are included as Annexes in the Workshop Report (Section 4 of this appendix).

For economy of time, the original workshop was held prior to obtaining the results of the PNS questionnaire and prior to performing the SFA. However, the preliminary results of the PNS were available for the panel as a focus of attention. It was also obvious to JPL that the original workshop had been too short to provide sufficient time for learning and deliberation of the panel members.

Thus, three of the seven workshop panel members were invited back to JPL in April, 1988, for a second meeting (held on April 19 and 20). The goal of this meeting was to obtain input from the outside members and to review the JPL results for:

a. Definition of the technologies that needed to be developed.

b. Identification of what is missing in the technologies identified by JPL.

c. Determination of what the Army should do next (analysis, preliminary data, conduct lab or field tests, fabricate, etc.).

d. Estimation of the schedules and costs for (c).

e. Who could or should conduct the effort defined in (c) and (d). (Army laboratory, academic institution, or private industry).

f. Priority ranking of the technologies that should be developed, considering not only need but cost, chances of success, etc.

This meeting was attended by Dr. Anthony Francis, who has expertise in materials and chemistry; Dr Robert Hennessey, a psychologist with broad experience in human factors and training for the military and NASA; and

COL(ret) Richard Edwards, who was very instrumental in the formation, organization, and completion of the National Training Center at Fort Irwin, California.

The meeting was held for two days using two formats. In some sessions, all attendees convened together. In other sessions, small groups of three or four persons (including only one of the consultants) were organized to focus on issues more pertinent to areas of expertise of each individual consultants.

This meeting proved to be more productive than the first meeting. The consultants were more familiar with the TES study objectives based on the first meeting. The PNS results and the SFA had been completed. The minutes of this meeting are included as Section 5 of this appendix. Also included in Section 5 as an addendum to the minutes are additional comments received from two of the participants (Dr. Hennessy and Dr. Francis) after the meeting.

The major areas of emphasis for the meeting were the same nine categories of future generation TES identified earlier:

1. The instrumented platform
2. Smart weapons
3. Simulated accurate gunnery
4. Air defense
5. Artillery and mortars
6. FASCAM
7. MOUT
8. Command and Control
9. Obscurants.

Many of the recommendations given in the following sections crystallized from these discussions. Some of the salient points that were made are:

The next generation should consider two-way communication between weapon and target, rather than the one-way communication existing with MILES.

Different architectures for TES might be more suitable for light weaponry (dismounted troops) than heavy (armor) or for air vs. ground because of the significant differences in the weapon systems.

The Army is not taking advantage of all the information that becomes available during force-on-force maneuver training. The concept of augmented feedback was discussed at length. The TES system should not necessarily simulate only the actual battlefield, but can and should provide additional feedback to the trainees for improved learning. One of the major technical advancements that the next TES system could make might be in better analysing and displaying the results of the exercises for improving this augmented feedback. Experience of JPL personnel indicates that the cadre at NTC does not take advantage of all the capabilities of the existing NTC

system. After Action Reviews for the lower unit sizes need improvement in content and timing.

The technology that impacts the training arena and the future generations of TES can be divided into two categories: these can best be called enabling and implementing technologies. Enabling technologies involve general areas of basic research that require high levels of funding; PM TRADE does not have the resources to contribute significantly to these areas. Implementing technologies are those where the fundamental technology is developed, but some work is necessary to implement this discipline for application to TES.

# APPENDIX D

## SECTION 2

## TES TECHNOLOGY DEVELOPMENT PRIORITIZATION

# TES TECHNOLOGY DEVELOPMENT PRIORITIZATION

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| A | TYPE OF TRAINING. | |
| A 1. | Maneuver | Highest |
| A 2. | Gunnery | High |
| A 3. | Command/leader | Priority |
| A 4. | Command and Control Staff | Priority |
| A 5. | Crew Skills | High |
| A 6. | Technical Skills | Priority |
| A 7. | Combat Support | Priority |
| A 8. | Combat service support | None |
| A 9. | Multi-Echelon | Priority |
| A 10. | With Foreign Units | None |
| A 11. | MOUT | Priority |
| B | LOCATION OF TRAINING. | |
| B 1. | Theater (Reforger-type exercises) | Priority |
| B 2. | Major training centers (such as NTC) | Highest |
| B 3. | Smaller training centers (such as JRTC) | Highest |
| B 4. | Dedicated testing centers (such as Ft. Hunter-Liggett) | High |
| B 5. | Large home stations (such as Ft. Hood and Ft. Lewis) | Highest |
| B 6. | Smaller home stations (such as Ft. Carson) | Highest |
| B 7. | Schools | Priority |
| B 8. | National Guard Armory | Priority |
| B 9. | Army reserve Training Center Area | Priority |
| C | UNIT SIZE. | |
| C 1. | Individual | High |
| C 2. | Crew/team | Highest |
| C 3. | Squad/Section | Highest |
| C 4. | Platoon/Troop | Highest |
| C 5. | Company | Highest |
| C 6. | Battalion | High |
| C 7. | Battalion Task Force | High |
| C 8. | Regiment/Brigade | Priority |
| C 9. | Division | None |
| C 10. | Corps/Echelons above Corps | None |

TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| D | TYPE OF INSTRUMENTED PLATFORM. | |
| D 1. | Dismounted troops. | Highest |
| D 2. | Crew-served ground weapons (dismounted). | Highest |
| D 3. | Armored vehicle. | Highest |
| D 4. | Non-armored vehicles | High |
| D 5. | Air defense artillery. | High |
| D 6. | Self-propelled howitzers | High |
| D 7. | Towed howitzers. | High |
| D 8. | Attack helicopters | Highest |
| D 9. | Scout helicopters. | Highest |
| D 10. | Transport helicopters. | High |
| D 11. | Surveillance aircraft. | High |
| D 12. | Low speed aircraft | High |
| D 13. | High speed aircraft. | Priority |
| D 14. | Combat service support vehicles. | Priority |
| D 15. | All platforms/vehicles on the battlefield. | Priority |
| E | TYPE OF WEAPONS. | |
| E 1. | Pistol | None |
| E 2. | Rifle. | Highest |
| E 3. | Machine gun. | Highest |
| E 4. | Hand grenade | Priority |
| E 5. | Grenade launcher | High |
| E 6. | Explosive charges. | Priority |
| E 7. | Mines, conventional. | High |
| E 8. | Mines, scatterable | High |
| E 9. | Mines Chemical | Priority |
| E 10. | Mortar | Priority |
| E 11. | Tank/fighting vehicle weapons. | Highest |
| E 12. | Air defense. | High |
| E 13. | Antitank guided missiles | Highest |
| E 14. | Artillery, conventional. | High |
| E 15. | Artillery, rocket. | Priority |
| E 16. | Artillery, chemical. | High |
| E 17. | Aircraft bombs/cluster bombs | Priority |
| E 18. | Air-to-air | Priority |
| E 19. | Air-to-surface | Priority |
| E 20. | Directed energy. | High |

TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| F | SMART WEAPONS. | |
| F 1. | Weapon assembly and setup. . . . . | None |
| F 2. | Weapon checkout. . . . . | None |
| F 3. | Loading. . . . . | Priority |
| F 4. | Target acquisition . . . . . | High |
| F 5. | Aiming and tracking. . . . . | Highest |
| F 6. | Firing . . . . . | Highest |
| F 7. | Weapon firing signatures . . . . . | High |
| F 8. | Target area effects. . . . . | High |
| F 9. | Realtime casualty assessment . . . . . | High |
| F 10. | Integration of all of the above. . . . . | High |
| G | SIMULATED GUNNERY. | |
| G 1. | Shoot-on-the-move. . . . . | Highest |
| G 2. | Shoot at moving targets. . . . . | Highest |
| G 3. | Target lead. . . . . | High |
| G 4. | Wind effects on ballistics . . . . . | Priority |
| G 5. | Selection of ammunition. . . . . | High |
| G 6. | Ranging. . . . . | High |
| G 7. | Ballistics . . . . . | High |
| G 8. | Simulation of weapon hold-on-target time . . . . . | High |
| G 9. | Provide countermeasure effects . . . . . | High |
| G 10. | Burst-on-target-cue. . . . . | High |
| G 11. | Tracers. . . . . | Priority |
| G 12. | Firing cues and signatures . . . . . | High |
| G 13. | TES to supplement live fire gunnery training . . . . . | High |
| G 14. | TES to replace live fire gunnery training. . . . . | None |
| G 15. | Provide same system operation and problems . . . . . | High |
| G 16. | Simulation of recoil . . . . . | Priority |
| G 17. | Simulation of loading rounds . . . . . | Priority |
| G 18. | Zero or boresight of weapon. . . . . | High |
| G 19. | Dry-firing of weapon . . . . . | None |
| G 20. | Real-time feedback to gunner after a miss. . . . . | High |

## TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| H | EMBEDDING. | |
| H 0. | Embedding is not desirable. | |
| H 1. | Small arms | None |
| H 2. | Crew-served weapons. | Priority |
| H 3. | Armored vehicles | High |
| H 4. | Non-armored vehicles | None |
| H 5. | Artillery. | Priority |
| H 6. | Helicopters. | High |
| H 7. | Aircraft | Priority |
| H 8. | Provide wartime engagement rehearsal capability. | Priority |
| I | AIR DEFENSE. | |
| I 1. | Provide TES which replicates air defense gunnery | High |
| I 2. | Provide instrumented RPVs as shoot-back targets. | Priority |
| I 3. | Instrument helicopters for air defense exercises | High |
| I 4. | Instrument low speed aircraft (A10). | High |
| I 5. | Instrument fast movers (F16s). | Priority |
| I 6. | Realistically simulate air defense missile systems | High |
| I 7. | Include capability for incoming attacking targets. | High |
| I 8. | Include IFF in all engagements | High |
| I 9. | Air defense range should be simulated out to: | |
| I 9. | Air defense range should be simulated out to 1 km. | Priority |
| I 9 | Air defense range should be simulated out to 10 km | Priority |
| I 9 | Air defense range should be simulated to weaponry range. | High |
| I 10. | Include the effects of Aircraft Survivability Equipment. | Priority |
| I 11. | Provide VISMODs for threat helicopters and aircraft. | Priority |
| I 12. | Provide video coverage to support After Action Reviews | Priority |

TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| J | ARTILLERY & MORTARS. | |
| J 1. | Loading rounds - procedures. | Priority |
| J 2. | Loading rounds - weight of round | Priority |
| J 3. | Loading rounds - loading time fidelity | Priority |
| J 4. | Laying the weapon. | Priority |
| J 5. | Firing the weapon - procedure. | High |
| J 6. | Firing the weapon - recoil | None |
| J 7. | Firing the weapon - flash, bang, and smoke | Priority |
| J 8. | Adjustment of fire | Highest |
| J 9. | Target area cues for Forward Observer. | High |
| J 10. | Use of Battery Computer System (BCS) | High |
| J 11. | Use of TACFIRE | High |
| J 12. | Simulate/replicate entire command and control network. | Priority |
| J 13. | Simulate loss of communications. | None |
| J 14. | Defense of area. | Priority |
| J 15. | Counter battery fire | High |
| J 16. | Direct fire. | High |
| J 17. | Improved munitions( i.e., Copperhead) | High |
| J 18. | Selection, use, conservation, and resupply of ammunition | Priority |
| K | ARTILLERY & MORTAR EFFECTS. | |
| K 1. | Flash of incoming rounds | High |
| K 2. | Bang of incoming rounds. | High |
| K 3. | Smoke of incoming rounds | High |
| K 4. | Simulated ground burst | High |
| K 5. | Simulated air burst. | High |
| K 6. | Attrition of vehicles. | High |
| K 7. | Attrition of vehicle crews | High |
| K 8. | Attrition of dismounted troops | High |
| K 9. | Suppression. | High |
| K 10. | Simulation of damage to buildings. | None |
| K 11. | Simulation of damage to structures | None |
| K 12. | Real-time casualty assessment. | High |
| K 13. | Adjustment of fire | High |
| K 14. | Round-for-round-simulation | High |
| K 15. | Surprise | High |
| K 16. | Time fidelity for receipt of indirect fire | High |

TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| L | MINES. | |
| L 1. | Replicate the size of the mine being simulated . . . . . | Priority |
| L 2. | Replicate the weight of the mine being simulated . . . . . | Priority |
| L 3. | Replicate the trip mechanism of the mine . . . . . | High |
| L 4. | Reproduce detection characteristics of the mine. . . . . | High |
| L 5. | Simulate mines on a one-for-one basis. . . . . | Priority |
| L 6. | Simulate mines on a generic basis for AT and AP. . . . . | Priority |
| L 7. | Simulate the attrition and casualty effects. . . . . | High |
| L 8. | Simulate only the overall effects of the minefield . . . . . | Priority |
| L 9. | Provide for simulating the logistics of mines. . . . . | None |
| L 10. | Provide for simulating emplacement of mines. . . . . | High |
| L 11. | Provide for simulating arming of mines . . . . . | Priority |
| L 12. | Provide for disarming and retrieval of mines . . . . . | Priority |
| L 13. | Provide for simulating breaching operations. . . . . | High |
| L 14. | Provide for simulating breaching weapons . . . . . | Priority |
| L 15. | Provide real-time casualty assessment on vehicle . . . . . | High |
| L 16. | Provides real-time casualty assessment on personnel. . . . . | High |
| L 17. | Attrition of any player. . . . . | High |
| L 18. | Attrition of only major weapons. . . . . | None |
| L 19. | Mine reuse after using (refurbishment) . . . . . | Priority |
| L 20. | Threat mine warfare. . . . . | High |

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| M | NUCLEAR/BIOLOGICAL/CHEMICAL. | |
| M 1. | Training for individual soldier NBC skills alone . . . . . | Priority |
| M 2. | Training intended for NBC team skill . . . . . | High |
| M 3. | NBC training exercises separately from other training. . . . | None |
| M 4. | Integrated N, B, and C training exercise . . . . . | High |
| M 5. | Use of notional units and NBC events . . . . . | None |
| M 6. | Different NBC simulant realism according to exercise . . . . | Priority |
| M 7. | Use NBC warning and reporting systems and procedures . . . . | High |
| M 8. | NBC monitoring and survey teams. . . . . | High |
| M 9. | NBC simulation devices used by any individual soldier. . . . | High |
| M 10. | NBC simulation integrated into the medical . . . . . | Priority |
| M 11. | Flash/bang/smoke cues for nuclear events . . . . . | Priority |
| M 12. | Traveling through a simulated contaminated area. . . . . | High |
| M 13. | Nuclear training should be provided for unit size of:. . . . | |
| M 13. | Nuclear training should be provided for: Platoon . . . . . | High |
| M 13. | Nuclear training should be provided for: Battalion . . . . . | High |
| M 13. | Nuclear training should be provided for: Company . . . . . | High |
| M 13. | Nuclear training should be provided for: Squad . . . . . | High |
| M 13 | Nuclear training should be provided for: Larger than Bn. . . | None |
| M 14. | Nuclear simulation should provide for: . . . . . | |
| M 14. | Nuclear simulation should provide for: Dose rate . . . . . | Priority |
| M 14. | Nuclear simulation should provide for: Rate and total. . . . | High |
| M 14. | Nuclear simulation should provide for: Total dose. . . . . | Priority |
| M 14 | Nuclear simulation should provide for: Armor protection. . . | Priority |
| M 14 | Nuclear simulation should provide for: EMP/TREE. . . . . | High |
| M 15. | Simulation of biological toxins. . . . . | Priority |
| M 16. | Simulation of biological organisms . . . . . | Priority |
| M 17. | Contamination transfer:. . . . . | |
| M 17 | Contamination transfer: To interiors of vehicles . . . . . | Priority |
| M 17 | Contamination transfer: From one area to another . . . . . | Priority |
| M 18. | Provide surprise delivery to maneuver elements . . . . . | High |
| M 19. | Provide surprise Combat Support and CSS. . . . . | Priority |
| M 20. | Persistent decontamination similar to an actual agent. . . . | High |
| M 21. | Simulation of non-persistent agent . . . . . | High |
| M 22. | Simulation of persistent chemical agent. . . . . | High |
| M 23. | Delivery of chemical agents by aircraft. . . . . | Priority |
| M 24. | Delivery of chemical agents by indirect fire . . . . . | Priority |
| M 25. | MTCA when entering a contaminated area . . . . . | High |
| M 26. | Training in all MOPP levels. . . . . | Highest |

TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| N | MOUT. | |
| N 1. | Indication of damage to buildings or other structures. . . . | Priority |
| N 2. | Simulate the protection provided by structures . . . . . | High |
| N 3. | Simulate protection degradation from multiple hits . . . . . | Priority |
| N 4. | Casualties on personnel inside buildings or structures . . . | High |
| N 5. | Simulate TES weapons inside of buildings . . . . . | High |
| N 6. | Engage at night. . . . . | High |
| N 7. | Engage through obscurants. . . . . | High |
| N 8. | Engage at very close range . . . . . | High |
| N 9. | Simulate attrition from use of explosive charges . . . . . | Priority |
| N 10. | Emphasize the instrumentation of dismounted troops . . . . . | High |
| N 11. | Cues in MOUT:. . . . . | |
| N 11. | Cues in MOUT: Weapon firing. . . . . | High |
| N 11. | Cues in MOUT: Noise. . . . . | High |
| N 11. | Cues in MOUT: Flash. . . . . | High |
| N 11. | Cues in MOUT: Smoke. . . . . | High |
| N 11. | Cues in MOUT: Pellets, dye or colorant to mark hits. . . . . | Priority |
| N 11. | Cues in MOUT: Hit signatures . . . . . | High |
| N 11. | Cues in MOUT: Smoke from burning buildings . . . . . | Priority |
| O | COMMAND AND CONTROL. | |
| O 1. | Instrument command and control elements as targets . . . . . | High |
| O 2. | Simulate C&C functions one echelon higher. . . . . | Priority |
| O 3. | Instrument C&C elements one echelon higher . . . . . | None |
| O 4. | Simulate tactical C&C systems such as TACFIRE. . . . . | Priority |
| O 5. | Simulate artillery FO, FAC, FDC, and ALO . . . . . | High |
| O 6. | Provide data or video of C&C of play for AAR . . . . . | High |
| O 7. | Provide TES communications data. for AAR . . . . . | High |
| P | COMBAT SUPPORT. | |
| P 1. | Instrument combat support vehicles only. . . . . | Priority |
| P 2. | Instrument combat support personnel only . . . . . | Priority |
| P 3. | Instrument all potential combat support targets. . . . . | High |
| P 4. | Simulate combat support and CSS elements . . . . . | Priority |
| P 5. | Provide logistics realism. . . . . | High |
| P 6. | Provide for field medical actions. . . . . | High |
| P 7. | Provide for problems of casualty evacuation. . . . . | High |
| P 8. | Provide for problems of resupply . . . . . | High |
| P 9. | Provide for problems of damage repair/retrieval. . . . . | High |

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| Q | COMMUNICATION DISRUPTION. | |
| Q 1. | Provide actual disruption of communications. . . . . | High |
| Q 2. | Provide simulated disruption of communications . . . . . | Priority |
| Q 3. | Use actual RF jamming techniques . . . . . | High |
| Q 4. | Disrupt communications by non-RF methods . . . . . | Priority |
| Q 5. | Disrupt only selected channels . . . . . | Priority |
| Q 6. | Automatically attrit equipment not protected . . . . . | Priority |
| Q 7. | Penalize excessive transmission time . . . . . | Priority |
| Q 8. | Simulate communication equipment damage. . . . . | Priority |
| Q 9. | Allow simulated repair of equipment/replacement. . . . . | Priority |
| Q 10. | Provide for antenna blowoff and field expedient. . . . . | Priority |
| Q 11. | Simulate electromagnetic interference on sights. . . . . | Priority |
| Q 12. | Simulate interference on other equipment . . . . . | Priority |
| R | OPFOR. | |
| R 0. | OPFOR is not necessary. | |
| R 1. | Threat maneuver tactics and doctrine . . . . . | Highest |
| R 2. | Actual OPFOR vehicles. . . . . | Priority |
| R 3. | VISMODS for OPFOR vehicles . . . . . | High |
| R 4. | Actual threat weapons. . . . . | Priority |
| R 5. | Threat weapons characteristics only. . . . . | High |
| R 6. | Threat weapon performance:. | |
| R 6. | Latest (classified) capability. . . . . | Priority |
| R 6. | Available capability. . . . . | High |
| R 7. | Simulation of threat target vulnerability:. | |
| R 7. | Latest (classified) capability. . . . . | High |
| R 7. | Available (unclassified) capability . . . . . | High |
| R 8. | Threat uniforms. . . . . | High |
| S | OBSCURATION. | |
| S 1. | Shoot through obscurants . . . . . | High |
| S 2. | Sight through obscurants . . . . . | High |
| S 3. | Shoot through soft cover . . . . . | High |
| S 4. | Provide IR-opaque training smoke . . . . . | Priority |
| S 5. | Simulate only the effects of IR-opaque smoke . . . . . | None |
| S 6. | Simulate delivery of obscurants by artillery . . . . . | Priority |
| S 7. | Simulate delivery of obscurants by Chemical Corps units. . . | Priority |

## TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| T | SIGNATURES. | |
| T 1. | Signatures as cues for the firer | High |
| T 2. | Signatures as cues for the target | High |
| T 3. | Hit flash | High |
| T 4. | Kill smoke | High |
| T 5. | Weapon flash | High |
| T 6. | Weapon smoke | High |
| T 7. | Weapon bang | High |
| T 8. | Tracers | Priority |
| T 9. | Burst on target | High |
| T 10. | Incoming artillery or mortar flash | High |
| T 11. | Incoming artillery or mortar bang | High |
| T 12. | Incoming artillery or mortar smoke | High |
| T 13. | Mine flash | High |
| T 14. | Mine bang | High |
| T 15. | Mine smoke | High |
| T 16. | Different signatures for different weapons | High |
| T 17. | Different signatures for different ammunition | Priority |
| T 18. | Signatures through sight imaging systems | High |
| U | ATTRITION. | |
| U 1. | Multiple levels of hits on vehicles | High |
| U 2. | Higher probability of kill for subsequent hits | High |
| U 3. | Hit quadrant on a vehicle | High |
| U 4. | The effect on kill probability from impact angle | Priority |
| U 5. | Multiple levels on individuals, such as torso, arm, leg | None |
| U 6. | Head shot on individuals (helmet detectors) | Priority |
| U 7. | Indication of who shot whom (for After Action Reviews) | High |
| U 8. | Distinguish/identify friendly kills (fratricide) | High |
| V | CASUALTY ASSESSMENT. | |
| V 1. | For vehicles, loss of mobility | High |
| V 2. | Loss of radio | Priority |
| V 3. | Attrition of individual crew members | High |
| V 4. | Casualty assessed automatically by TES instead of cards | Priority |
| V 5. | Indication of location, type, and severity of wounds | Priority |
| V 6. | Elimination of controller-assessed kills | None |

## TES Technology Development

| | PNS QUESTION | JPL Recommended Priority |
|---|---|---|
| W | INTEROPERABILITY. | |
| W 1. | MILES. . . . . | Highest |
| W 2. | UCOFT, or similar crew trainers. . . . . | Priority |
| W 3. | TWGSS, or similar gunnery trainers . . . . . | High |
| W 4. | ARTBASS, or other staff trainers . . . . . | Priority |
| W 5. | Test instrumentation . . . . . | Priority |
| W 6. | Other NATO TES systems such as SIMFIRE or Tallissi . . . . . | Priority |
| W 7. | Future new equipment capabilities. . . . . | High |
| W 8. | Future improvements to current tactical equipment. . . . . | High |
| W 9. | Future threat equipment and capabilities . . . . . | High |
| X | CHEATING. | |
| X 0. | Cheating is not important in TES system. | |
| X 1. | Systems should be as cheat-proof as they can be made . . . . | High |
| X 2. | TES systems should indicate when cheating has occurred . . . | High |
| X 3. | Use of MILES-type keys should be eliminated. . . . . | Priority |
| X 4. | Equipment should be made more tamper-proof . . . . . | High |
| X 5. | The number of soldier-operated controls should be minimized. | High |
| X 6. | More functions should be delegated to controllers. . . . . | None |
| Y | CONTROLLERS. | |
| Y 1. | Control the flow of the exercise . . . . . | High |
| Y 2. | Arbitrate problems and disputes as referees. . . . . | High |
| Y 3. | Evaluate trainees. . . . . | Priority |
| Y 4. | Assess casualties. . . . . | None |
| Y 5. | Prevent cheating . . . . . | High |
| Y 6. | Emphasis should be to decrease the number of controllers . . | High |
| Y 7. | More use of controllers from other than combat units . . . . | None |
| Y 8. | TES should reduce the workload on controllers. . . . . | High |

| PNS QUESTION | JPL Recommended Priority |
|---|---|
| Z POSITION LOCATION. | |
| Z 1. Location of every player | None |
| Z 2. Location of major weapons only (tank, TOW, etc.) | High |
| Z 3. Location of all but dismounted individual troops | None |
| Z 4. Location to within 100 meters | None |
| Z 5. Location to within 10 meters | None |
| Z 6. Location to within 1 meter | None |
| Z 7. Include altitude as well as X, Y coordinates | None |
| Z 8. Include orientation of vehicle | None |
| Z 9. Include orientation of weapon | None |
| Z 10. Location continuously updated | None |
| Z 11. Location needed only when engaging (or being engaged) | Priority |
| AA INTERVISIBILITY. | |
| AA 0. Intervisibility not important in future training exercises | |
| AA 1. Include intervisibility in all levels of training | Priority |
| AA 2. Include intervisibility only for major weapon systems | High |
| AA 3. Provide intervisibility as a option only for gunnery | Priority |
| BB DATA COLLECTION. | |
| BB 1. Simplify equipment by minimizing automatic data collection | None |
| BB 2. Provide on-board storage of some engagement data | Priority |
| BB 3. Provide for real-time display or transmission of TES data | Priority |
| BB 4. Provide video taping of overall maneuver areas | Priority |
| BB 5. Provide video taping of sight pictures | None |
| BB 6. Provide computer graphics for After Action Reviews | Priority |
| BB 7. Include player position location in TES instrumentation | Priority |
| BB 8. Include firing weapon ID in the data sent to the target | High |
| CC SIZE. | |
| CC 1. Future TES should be smaller than MILES | High |
| CC 2. Size is more important than increased capability | None |
| CC 3. Reduce size to improve transparency to the user | Priority |
| CC 4. Eliminate helmet detectors and associated electronics | None |

| PNS QUESTION | JPL Recommended Priority |
|---|---|
| DD WEIGHT. | |
| DD 1. Maximum for infantry must be: | |
| DD 1. Maximum for infantry must be: Less than 2 pounds . . . . . | High |
| DD 1. Maximum for infantry must be: Less than 10 pounds. . . . . | Priority |
| DD 1. Maximum for infantry must be: Less than 20 pounds. . . . . | None |
| DD 2. Maximum on a helicopter must be:. | |
| DD 2. Maximum on a helicopter must be: Less than 200 pounds. . . . | None |
| DD 2. Maximum on a helicopter must be: Less than 50 pounds . . . . | High |
| DD 3. Maximum on a aircraft must be:. | |
| DD 3. Maximum on a aircraft must be: Less than 200 pounds. . . . . | None |
| DD 3. Maximum on a aircraft must be: Less than 50 pounds . . . . . | High |
| EE TYPE OF ELECTRICAL POWER. | |
| EE 1. Use of vehicle power whenever possible . . . . . | High |
| EE 2. Use of special high performance batteries. . . . . | None |
| EE 3. Use standard commercial batteries. . . . . | None |
| EE 4. Use rechargeable batteries . . . . . | Priority |
| EE 5. Minimize use of batteries. . . . . | Priority |
| EE 6. Provide longer power duration than MILES . . . . . | Priority |
| FF BUILT-IN TEST (BITE). | |
| FF 0. BITE is not important to future TES. | |
| FF 1. BITE operable by user. . . . . | Priority |
| FF 2. BITE operable by repair personnel only . . . . . | Priority |
| FF 3. Activates automatically. . . . . | Priority |
| FF 4. System-level BITE (Go/no go only). . . . . | Priority |
| FF 5. System-level BITE (which component is bad) . . . . . | Priority |
| FF 6. Component level BITE (what's wrong). . . . . | Priority |
| GG INSTALLATION. | |
| GG 1. More permanent installation. . . . . | None |
| GG 2. Much easier to install than MILES. . . . . | High |
| GG 3. Installation at a TES installation facility. . . . . | None |
| GG 4. Installation anywhere in the field . . . . . | High |
| GG 5. installation by civilian personnel . . . . . | Priority |
| GG 6. Installation by military personnel . . . . . | High |
| GG 7. Installation by specialists. . . . . | None |

## TES Technology Development

| PNS QUESTION | JPL Recommended Priority |
|---|---|
| HH ISSUE. | |
| HH 1. Some components should be kept by each soldier . . . . . | None |
| HH 2. Future TES should be resident in the battalion . . . . . | High |
| HH 3. Future TES should be issued from TASC as it is now . . . . . | None |
| HH 4. TES equipment issued should be boxed for two man carry . . . | Priority |
| HH 5. Emphasis should be placed on expendable devices. . . . . | None |
| HH 6. TES equipment sets should include test equipment . . . . . | Priority |
| HH 7. Each battalion should have TES equipment for a platoon . . . | High |
| II MAINTENANCE. | |
| II 1. Components designed for maximum serviceability in the unit . | High |
| II 2. TES designed for easy fault isolation: . . . . . | |
| II 2. TES designed for easy fault isolation: By troops . . . . . | Priority |
| II 2. TES designed for easy fault isolation: By CLS only . . . . . | None |
| II 2. TES designed for easy fault isolation: By TASC . . . . . | Priority |
| II 3. Component replacement in the field . . . . . | High |
| II 4. Component replacement by TASC. . . . . | Priority |
| II 5. Component repair by TASC . . . . . | Priority |
| II 6. Repair by military personnel . . . . . | High |
| II 7. Repair by civilian personnel . . . . . | Priority |
| JJ TES EQUIPMENT TRAINING. | |
| JJ 1. Introduction to TES as part of basic training. . . . . | Priority |
| JJ 2. Expand to include the limitations inherent in simulation . . | Priority |
| JJ 3. Expand to include maintenance and fault isolation. . . . . | Priority |
| JJ 4. Provide more training aids for the installation of TES . . . | Priority |
| JJ 5. Provide more training aids for maintenance of TES. . . . . | None |
| JJ 6. Provide videotapes for TES training. . . . . | Priority |
| JJ 7. Provide simulators for classroom/dayroom training. . . . . | None |
| JJ 8. Provide training aids for controllers. . . . . | Priority |
| KK TARGETS. | |
| KK 1. Cues to indicate hit or near miss or kill. . . . . | High |
| KK 2. Hit sensors on targets . . . . . | High |
| KK 3. Targets with capability for simulated shootback. . . . . | High |
| KK 4. RTCA for near miss, hit, or kill of targets. . . . . | High |
| KK 5. Probability of kill adjusted for number of hits on target. . | High |
| KK 6. Weapon and target pairing data when a target is observed . . | Priority |
| KK 7. Weapon and target pairing data when a weapon is fired. . . . | Priority |
| KK 8. Weapon and target pairing data when a hit is accomplished. . | High |

APPENDIX D

SECTION 3

JPL AREAS FOR TES TECHNOLOGY DEVELOPMENT

# INTRODUCTION

The following discussion presents a summary conclusion statement for each question, based on the Prioritized Needs Summary (PNS) results and technology issues. (As directed by the SAG, JPL eliminated any need with a priority of *None* from further consideration.) Each major PNS question and sub-question have been separated by JPL into four categories:

1. Technology Development Needed

   a. JPL will determine one or more technologies that the Army should investigate to satisfy this need.

   b. Integrate this need with another need because the technology development approaches would be the same for both.

   c. Determine that the need is not technically achievable.

NOTE: Cost and safety issues are not addressed because these are not defined until after an approach is defined and some design accomplished (both beyond the TES scope).

2. Technology Development Not Needed:

   a. The technology to accomplish the prioritized need already exists.

   b. The need can be and is better satisfied by being widely integrated as a future requirement into MILES Product Improvement Programs (PIPs) or future TES hardware or software.

   c. The question or sub-question is a need that can be accomplished by Army policy.

NOTE: These sub-questions will not be pursued in any further JPL TES study effort.

3. Technology Development Needed but Priority Ranking is Too Low to Pursue:

   a. JPL, as directed by the SAG, will consider for technology development recommendations only those PNS needs that had a technology development priority of *Highest* or *High*.

b. However, JPL will evaluate those PNS needs with a ranking of *Priority* to determine if they can be accomplished within the technologies being recommended by JPL for development (after these are determined for the priorities of *Highest* and *High*).

4. Technology Development Not Needed for *Priority*-Ranked Needs:

   This is the same as item (2).

## PNS QUESTIONS

A TYPE OF TRAINING.
Importance of the types of training for which TES should be developed.

**Topic Question Overall Conclusion:** The ranking of HIGHEST was given to Maneuver as can be expected; with gunnery and crew skills ranked as HIGH. There was no priority given to use with foreign units or to including Combat Service Support units in TES (this latter is in opposition for including the Medical Corp which is a PRIORITY ranked item)

**Technology:** The response indicates that the future TES should use technology that permits Maneuver, Gunnery and Crew Skills training. This question has no direct technology development issues, but JPL believes that if future TES can satisfy these three items then the TES system should be able to also accomplish training in all PRIORITY items except MOUT. The Command/leader and Command and Control Staff would be trained by the real events that occur in a TES field exercise (note that all TES players are to be instrumented as targets).

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| A 1. Maneuver | HIGHEST |
| A 2. Gunnery | HIGH |
| A 5. Crew Skills | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| A 3. Command/leader | PRIORITY |
| A 4. Command and Control Staff | PRIORITY |
| A 6. Technical Skills | PRIORITY |
| A 7. Combat Support | PRIORITY |
| A 9. Multi-Echelon | PRIORITY |
| A 11. MOUT | PRIORITY |
| Needs Eliminated From Consideration: | |
| A 8. Combat service support | NONE |
| A 10. With Foreign Units | NONE |

B LOCATION OF TRAINING.
Importance of the type of location where TES should be used.

**Topic Question Overall Conclusion:** TES should be usable at all Army training areas from a small local training area to a theater operation. As HIGHEST priority TES must be usable at the Major Training Centers, Large Home Stations and Smaller Home Stations. This would include the Maneuver Training Areas (MTA) but not the Local Training Areas (LTA) in Germany which JPL considers to be the same as the National Guard Armory or Army Reserve Training Center Area.

**Technology:** The response indicates that the future TES should use technology that permits training at Major Training Centers down to Smaller Home Stations (such as Ft. Carson). This question has no direct technology development issues, but if future TES can do HIGHEST and HIGH then the TES system technology should be able to accomplish training in all PRIORITY items without additional effort. Problems at Theater level exercises will be planning for enough equipment and having enough control personnel to permit force on force exercise. However, Theater level FonF exercises are not [ed word from bob]. It is assumed that the Reserve Components will be conducting TES training in training areas comparable to regular Army unit training sites.

A possible technology development issue is the differences (weapons and battlefield integration level, size of units, etc.) in TES training at instrumented training centers (like NTC) versus the capability of the un-instrumented home stations; JPL also assumes that the Dedicated Testing Centers re like the instrumented training centers. For example, if TES training in fog-oil smoke is limited to instrumented ranges (like NTC) then the range instrumentation (PLS, communications and computer systems) could be used to aid the Firing Through Obscurants Simulation, and a simulation system that did not require range instrumentation for smoke obscurants would not be needed or justified.

If the size and level of training at instrumented ranges can make use of the range PLS and communications capability

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed: None.** | |
| **Technology Development Not Needed:** | |
| B 2. Major training centers (such as NTC) . . . . . | HIGHEST |
| B 3. Smaller training centers (such as JRTC). . . . . | HIGHEST |
| B 4. Dedicated testing centers (such as Ft. Hunter-Liggett) . . . | HIGH |
| B 5. Large home stations (such as Ft. Hood and Ft. Lewis) . . . . | HIGHEST |
| B 6. Smaller home stations (such as Ft. Carson) . . . . . | HIGHEST |

**Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None**

Technology Development Not Needed For These PRIORITY Ranked Needs:

B 1. Theater (REFORGER-type exercises). . . . . PRIORITY
B 7. Schools. . . . . PRIORITY
B 8. National Guard Armory . . . . . PRIORITY
B 9. Army reserve Training Center Area. . . . . PRIORITY

Needs Eliminated From Consideration: None.

C UNIT SIZE.

Importance of the unit size for which TES should be used in future training.

**Topic Question Overall Conclusion:** Emphasis in the PNS was placed on using TES for small unit training exercises; even individual training was ranked as HIGH priority. TES devices, or portions thereof, should be able to be used from Platoon/Troop, Company, or Squad/Section (all of these small units were ranked as HIGHEST priority indicating the Need for TES to be used in small unit training at home stations). HIGH priority ranking was given to battalion and larger size units in larger training areas. The consideration at NTC for training up to a Brigade slice would be included in Regiment/Brigade (C8) which only ranked PRIORITY. There was no priority given to Division or larger echelons. Also Division and higher units (C9 and 10) conflict with the response given for Theater location (B1).

**SAG Issue:** Inclusion of Brigade Slice and the technology for all of the elements within the brigade. [what are these; does brigade have only a command and staff field function]

**Technology:** The response indicates that the future TES should use technology that facilitates TES training from individual (in TES context this means exercising individual skills not individual skill training) through Battalion Task Force. Regiment/Brigade slice should also be within the scope. This question has no direct technology development issues.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed: None.** | |
| **Technology Development Not Needed:** | |
| C 1. Individual | HIGH |
| C 2. Crew/team | HIGHEST |
| C 3. Squad/Section | HIGHEST |
| C 4. Platoon/Troop | HIGHEST |
| C 5. Company | HIGHEST |
| C 6. Battalion | HIGH |
| C 7. Battalion Task Force | HIGH |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.** | |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| C 8. Regiment/Brigade | PRIORITY |
| **Needs Eliminated From Consideration:** | |
| C 9. Division | NONE |
| C 10. Corps/Echelons above Corps | NONE |

D TYPE OF INSTRUMENTED PLATFORM.

Importance of the types of player (or platform) that should be instrumented (i.e., capable of engaging or being engaged) with TES systems.

Topic Question Overall Conclusion:
All of the players, platforms and vehicles on the TES battlefield need to be instrumented if they can be engaged as a target; however instrumenting every player on the training battlefield, which seems important, is not of significant interest (D15). Of the 15 identified in PNS questions four, Armor, dismounted crew weapons, attack helicopters, and dismounted troops, were ranked as HIGHEST; these are currently equipped with MILES. Seven of those that we don't instrument now were ranked as HIGH; included in these are those that can be considered to be soft. Only a PRIORITY ranking was given to aircraft, and CSS vehicles.

Technology: JPL assumes that technology exists such that if an armored weapons platform can be instrumented then any other platform type can be instrumented as a target; thus, for example if one can instrument an Attack Helicopter then technology is available such that a Scout Helicopter can be instrumented. Soft platforms also include supplies, POL and ammunition, vehicles, recovery operations, command and communication vehicles, FIST, FO, ALO, etc; these also do not present a technology problem. For artillery howitzers technology is needed for: counter battery, sensors/RTCA, direct howitzer defensive fires (D6 and 7). Low and high speed aircraft have need for airworthiness technology for sensors and weapons; this is not an issue--JPL will not do anything about airworthiness.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| D 2. Crew-served ground weapons (dismounted) | HIGHEST |
| D 3. Armored vehicle | HIGHEST |
| D 5. Air defense artillery | HIGH |
| D 6. Self-propelled howitzers | HIGH |
| D 8. Attack helicopters | HIGHEST |
| D 12. Low speed aircraft | HIGH |
| **Technology Development Not Needed:** | |
| D 1. Dismounted troops | HIGHEST |
| D 4. Non-armored vehicles | HIGH |
| D 7. Towed howitzers | HIGH |
| D 9. Scout helicopters | HIGHEST |
| D 10. Transport helicopters | HIGH |
| D 11. Surveillance aircraft | HIGH |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| D 13. High speed aircraft | PRIORITY |
| D 15. All platforms/vehicles on the battlefield | PRIORITY |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| D 14. Combat service support vehicles | PRIORITY |

**Needs Eliminated From Consideration: None.**

E TYPE OF WEAPONS.

Importance of the type of weapons that should be simulated in a future TES system.

**Topic Question Overall Conclusion:** There is a large spread in priority ratings given to different weapon systems. The rank of HIGHEST is given to four weapons: Machine gun, Tank weapons, Rifle and AT missiles. Air defense, Artillery, and Grenade Launcher all had a ranking of HIGH. Of the 20 weapons 12 were ranked PRIORITY, and one, the pistol (which Loral has accomplished within MILES technology for police and terrorist training) with a priority of NONE, need not be included in TES (we assume this is because TES field exercises do not get close enough for hand to hand and bayonet combat, hand grenade and pistol use. Twelve of these will not be included in the TES technology development effort.

**Technology:** JPL assumes that if one can simulate the weapon's effects, with some fidelity, then how the weapon is used in the future will not affect TES technology development. Weapon improvements would also have to include TES improvements as Product Improvement Program (PIP); many of these may be in TES software which may indicate the need for technology to easily update or change the software (like weapons effects in Player Detector Device).

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| E 5. Grenade launcher | HIGH |
| E 8. Mines, scatterable | HIGH |
| E 11. Tank/fighting vehicle weapons | HIGHEST |
| E 12. Air defense | HIGH |
| E 13. Antitank guided missiles | HIGHEST |
| Problem is in Smart Guided Missiles. TOW MILES is adequate technology. | |
| E 20. Directed energy | HIGH |
| **Technology Development Not Needed:** | |
| E 2. Rifle | HIGHEST |
| E 3. Machine gun | HIGHEST |
| It is assumed that Rifle and Machine gun laser (MILES) technology is adequate. | |
| E 7. Mines, conventional | HIGH |
| It is assumed that SAWE MES is adequate technology. | |
| E 14. Artillery, conventional | HIGH |
| Assume that SAWE IFS Acoustic or RF is adequate; problem is providing the volume needed for suppressive fires. | |
| E 16. Artillery, chemical | HIGH |
| Technical solution was given in NBC BTA for non-persistent. Persistent can't be done by SAWE IFS due to requirement for large volume of dispersed material. Alarms based on ion mobility (like Chemical Agent Monitor (CAM)) can be activated by SPAL and may be activated by SAWE IFS projectile filled with "trigger" chemical. | |

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:

E 9. Mines Chemical . . . . . PRIORITY
Problem is to disperse agent.

E 10. Mortar . . . . . PRIORITY
Problem is providing the volume needed and control of these fires; assume the if Artillery is done the Mortars can be done.

E 15. Artillery, rocket. . . . . PRIORITY
Problem is in simulation of threat rocket barrages. JPL will not consider.

E 17. Aircraft bombs/cluster bombs . . . . . PRIORITY
Problems: Interface with aircraft of simulator. Safety of dropping anything.

E 18. Air-to-air . . . . . PRIORITY
The interfaces between aircraft (all combinations of wing and rotor) during air to air combat requires technology. (JPL considers that air to air combat play within ground TES exercises to be not important as to the outcome of the TES battle exercise. Air to air effects are independent of the ground operations and can only result in losses of air capability which can be simulated by not having these assets in use--by and within exercise controller command structure; thus, the air to air can be trained outside of the TES ground exercise.)

E 19. Air-to-surface . . . . . PRIORITY

Technology Development Not Needed For These PRIORITY Ranked Needs:

E 4. Hand grenade . . . . . PRIORITY
It is assumed that hand grenade simulation can be made using SAWE MES technology.

E 6. Explosive charges. . . . . PRIORITY

Needs Eliminated From Consideration:

E 1. Pistol . . . . . NONE
Loral has accomplished this with MILES.

F SMART WEAPONS.

Importance of simulating "smart weapons" (such as Hellfire, Copperhead, SADARM, FOG-M, etc.) on the future TES training battlefield:

**Topic Question Overall Conclusion:** Aiming, tracking and firing are ranked HIGHEST; weapon assembly and checkout are NONE, and actual loading is PRIORITY; this indicates that the Army is interested most in the interaction with a target, and integration of the effects.

**Technology:** Smart Weapons was a TES Workshop Issue. There are significant technology issues for TES simulation of Smart Weapons.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| F 4. Target acquisition | HIGH |
| F 5. Aiming and tracking | HIGHEST |
| F 6. Firing | HIGHEST |
| F 8. Target area effects | HIGH |
| F 9. Real time casualty assessment | HIGH |
| F 10. Integration of all of the above | HIGH |
| **Technology Development Not Needed:** | |
| F 7. Weapon firing signatures | HIGH |
| JPL assumes that the signatures are at weapon when fired, and that technology for signatures is available. | |

**Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** None.

**Technology Development Not Needed For These PRIORITY Ranked Needs:**

| | |
|---|---|
| F 3. Loading | PRIORITY |

**Needs Eliminated From Consideration:**

| | |
|---|---|
| F 1. Weapon assembly and setup | NONE |
| F 2. Weapon checkout | NONE |

G SIMULATED GUNNERY.

Importance, in future TES, of the replication of the following gunnery characteristics.

Topic Question Overall Conclusion: It was evident from the PNS ranking that more realistic simulated gunnery needs to be included by TES in the force on force maneuver exercise. HIGHEST priority was given to being able to shoot on the move with lead simulation at moving targets. Of the twenty gunnery simulation questions two were HIGHEST Priority, 12 were rated HIGH and four (wind effects, ammunition loading, tracers and recoil) were ranked as PRIORITY. Thus, TES should exercise all of the gunnery elements.

The ability to use TES to dry fire the weapon was not considered to be important; and there was no desire to replace live fire with TES gunnery as this was marked as negative training.

Technology: The response indicates that the future TES should use technology that permits significantly more Gunnery and Crew Skills in TES training than MILES does currently. Except for obscuration (which is considered separately) simulated gunnery has no direct technology development issues because of the existence of several Gunnery Trainers for Tank Main Guns using advanced laser technology, and further advancement in this technology is expected to continue. TWGSS, when fielded, will have essentially this capability, but JPL assumes that the Army cannot afford to buy TWGSS for TES. Thus, there is the technology issue of much lower cost to attain this level of capability.

JPL assumes that with the interest in gunnery for the Tank Main Gun (TMG) that similar gunnery training will be desired with other main weapons, that are big battlefield killers, to make the simulation equal. These other weapons would then have the same technology needs as TMG.

The need for gunnery simulation in the degraded mode is a TES SAG issue. For degraded mode the simulation must provide all of the inputs needed without aid (data or computations) from existing or embedded gunnery system. JPL assumes that TWGSS will not have degraded mode capability.

There is the SAG issue of how much gunnery in TES is really needed if Army cannot afford TWGSS for TES.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: | |
| G 1. Shoot-on-the-move. . . . . | HIGHEST |
| G 2. Shoot at moving targets. . . . . | HIGHEST |
| G 3. Target lead. . . . . | HIGH |
| G 6. Ranging. . . . . | HIGH |

Requires TES data flow between target and weapon.

G 10. Burst-on-target-cue. . . . . HIGH
There are three modes: one (a) is presentation to gunner in his sights the "fall of shot"; another (b) is cue to the other players; and (c) burst of near or far misses to other players. Technology exists for all three: for (a) TES could add something to real sight; for (b) there is a safety issue if burst is pyrotechnic; however a Weapons Effects Simulator (WES) could provide this; for (c) there is also a safety issue and would be expensive to implement.

G 12. Firing cues and signatures . . . . . HIGH
All of the cues and signatures need a lower cost and safer technology than pyrotechnics. Army does not use some of these now, and has eliminated some. A TES Weapons Effects Simulator (WES) could provide these.

G 15. Provide same system operation and problems . . . . . HIGH
This would require technology and significant implementation costs if degraded modes are to be simulated; information from the sight or weapon would have to be provided tc TES as to what was degraded and how much, and the real weapon functions degraded by TES.

G 18. Zero or boresight of weapon. . . . . HIGH

G 20. Real-time feedback to gunner after a miss. . . . . HIGH

Technology Development Not Needed:

G 5. Selection of ammunition. . . . . HIGH

G 7. Ballistics . . . . . HIGH

G 8. Simulation of weapon hold-on-target time . . . . . HIGH

G 9. Provide countermeasure effects . . . . . HIGH
This can be done by RTCA interface when countermeasures are ON.

G 13. TES to supplement live fire gunnery training . . . . . HIGH
Not a technology issue. JPL will not consider.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:

G 4. Wind effects on ballistics . . . . . PRIORITY
Need real wind data from sensor; could also be done within gunnery TES computer. Gunner cannot affect wind effects except to shoot again.

G 11. Tracers. . . . . PRIORITY
Requires some information to gunner. Within sight same as fall of shot; real would require some technology definition. JPL will not consider.

G 16. Simulation of recoil . . . . . PRIORITY
Except for small weapons that can fire blanks, technology is needed.

G 17. Simulation of loading rounds . . . . . PRIORITY
JPL will not consider.

Technology Development Not Needed For These PRIORITY Ranked Needs: None.

Needs Eliminated From Consideration:

G 14. TES to replace live fire gunnery training. . . . . NONE
Note that PNS is choice between G13 and G14 with result that Army still wants Live Fire.

G 19. Dry-firing of weapon . . . . . NONE

H EMBEDDING.

Importance of the TES capability being permanently embedded in the weapon, vehicle, or aircraft, instead of being added on for training exercises.

**Topic Question Overall Conclusion:** The Embedding questions were answered by about 50% of the respondents; 56 responded that "Embedding is not desirable." The two with HIGH priority are the easiest to perform because of the sophistication of the weapon combat system.

Because the ranking of the six other subquestions were rated PRIORITY or lower there is either not much interest in having the TES equipment embedded, or not many believe that it will be accomplished or is the best way to obtain TES equipment (training considerations during weapon development hasn't happened in the past). If we, JPL, accept the Tank and Helicopter as the only two important weapon platforms that need embedded training devices, then embedding is not an issue for the SAG because both of these have sufficient sophistication to incorporate additional embedded simulation technology; however, because embedding is Official Army procurement policy the SAG should define for JPL just what is included in Embedding--is it software, hardware, changing boxes, etc.

**Technology:** JPL believes that to be implemented Embedded TES technical interfaces would need to have combat useful role. The use of existing computers to provide TES is not a problem; interjecting TES data into the combat system, laser or commo devices are. JPL will not consider the PRIORITY rated items, and they probably cannot be expected to all be accomplished with the Tank and Helicopter technology.

Embedding was a TES Workshop Issue, and we were correct.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| H 3. Armored vehicles | HIGH |
| H 6. Helicopters | HIGH |
| **Technology Development Not Needed:** None | |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| H 2. Crew-served weapons | PRIORITY |
| H 5. Artillery | PRIORITY |
| H 7. Aircraft | PRIORITY |
| H 8. Provide wartime engagement rehearsal capability | PRIORITY |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** None. | |
| **Needs Eliminated From Consideration:** | |
| H 1. Small arms | NONE |
| H 4. Non-armored vehicles | NONE |

I AIR DEFENSE.
Importance of the simulation of air defense as follows.

**Topic Question Overall Conclusion:** Army wants essentially the same for Air Defense (AD) as for tank gunnery with both aircraft and AD defense. The slow movers are more important than the fast movers. Identification of Friend or Foe (IFF) is to be played. Interestingly they want incoming attacking targets, but do not want Remote Piloted Vehicles (RPV's) as part of simulation.

**Technology:** The most significant technical problem is to provide for target lead; however, if the combat system calculates lead automatically then a laser pointed at the target, or target on sight crosshairs is adequate for TES. For example, when a squad leader tells the riflemen in his squad the amount to lead their aim when engaging an aircraft then the TES lead problem is solved with laser technology because the command could be changed in real combat and a zero lead should be sufficient for TES; SAG needs to verify that this is doctrine. This was a TES Workshop Issue, and still is.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| I 1. Provide TES which replicates air defense gunnery . . . . . | HIGH |
| I 4. Instrument low speed aircraft (A10). . . . . | HIGH |
| This has serious Air Force political and technical interface. | |
| I 6. Realistically simulate air defense missile systems . . . . . | HIGH |
| I 9 Air defense range should be simulated to weaponry range. . . | HIGH |
| **Technology Development Not Needed:** | |
| I 3. Instrument helicopters for air defense exercises . . . . . | HIGH |
| I 7. Include capability for incoming attacking targets. . . . . | HIGH |
| Unless using live fire (where killed targets would fall on A/D personnel and equipment) JPL will assume that RTCA sensors will be the same as for other platforms (targets). | |
| I 8. Include IFF in all engagements . . . . . | HIGH |
| Assume that real IFF will be used. JPL will not consider. | |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| I 5. Instrument fast movers (F16s). . . . . | PRIORITY |
| This has serious Air Force political and technical interface. | |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| I 2. Provide instrumented RPVs as shoot-back targets. . . . . | PRIORITY |
| Technology issue only if these have heavy TES payloads. | |
| I 10. Include the effects of Aircraft Survivability Equipment. . . | PRIORITY |
| Part of RTCA; if turned or used the kill or hit probability would be reduced. | |
| I 11. Provide VISMODs for threat helicopters and aircraft. . . . . | PRIORITY |
| I 12. Provide video coverage to support After Action Reviews . . . | PRIORITY |
| A/D video is same technology as for other engagements except that A/C should carry video. Air defense to be simulated out to weapon range. | |

**Needs Eliminated From Consideration:** None.

J ARTILLERY & MORTARS.

Importance of the simulation, at the battery, of artillery and mortars in the future TES system.

**Topic Question Overall Conclusion:** Army wants artillery and mortar tubes to be simulated in some manner, and wants the FO to have Flash, Bang and Smoke (FBS) cues for adjustment of fire; they consider this to be HIGHEST priority. Also, they want to simulate the command, control, and communications of these indirect fires, and they want counter battery and use of new improved conventional munitions simulated.

**Technology:** This is discussed under each question.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| J 9. Target area cues for Forward Observer. . . . . | HIGH |
| JPL SAWE IFS Acoustic Rounds could provide FO cues by firing into "adjustment of fire area" when dismounted personnel are not present. There is some question about what error 28 meters above the ground would cause in the FO being able to adjust from this air burst cue. There has to be a cue round as in JPL SAWE IFS. Could also provide a smoke streamer cue for adjustment of fire. | |
| J 15. Counter battery fire . . . . . | HIGH |
| Need whole new system of sensors, RTCA and commo. Could use SAWE IFS Launcher. | |
| **Technology Development Not Needed:** | |
| J 5. Firing the weapon - procedure. . . . . | HIGH |
| Use real procedures. | |
| J 8. Adjustment of fire . . . . . | HIGHEST |
| Use real adjustment of weapon; sensors and commo would be needed for error simulation. | |
| J 10. Use of Battery Computer System (BCS) . . . . . | HIGH |
| J 11. Use of TACFIRE . . . . . | HIGH |
| On J10 and J11 use real devices and system for TES. | |
| J 16. Direct fire. . . . . | HIGH |
| JPL assumes that MILES technology would be adequate | |
| J 17. Improved munitions( i.e., Copperhead). . . . . | HIGH |
| JPL assumes that TES round simulators can be made, as with "Blooper Rounds." JPL will not consider technology development for using these rounds at the battery; however, the use and weapon effects on targets will be considered. | |

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:

J 1. Loading rounds - procedures. . . . . PRIORITY

J 2. Loading rounds - weight of round . . . . . PRIORITY
Round has to be removed. JPL will not consider.

J 3. Loading rounds - loading time fidelity . . . . . PRIORITY

J 4. Laying the weapon. . . . . PRIORITY
Use real lay of weapon; sensors and commo would be needed for error simulation.

J 7. Firing the weapon - flash, bang, and smoke . . . . . PRIORITY
Technology is available from other cues for pyro.

J 12. Simulate/replicate entire command and control network. . . . PRIORITY
Use real network. Commo from controllers for small unit exercise.

J 14. Defense of area. . . . . PRIORITY
Use weapons; if direct fire with artillery or mortars then additional TES equipment for different use would be needed. The new 60mm mortar has this direct fire capability. JPL will not consider.

J 18. Selection, use, conservation, and resupply of ammunition . . PRIORITY

Needs Eliminated From Consideration:

J 6. Firing the weapon - recoil . . . . . NONE

J 13. Simulate loss of communications. . . . . NONE

K ARTILLERY & MORTAR EFFECTS.

Importance of the simulation of the effects, in the target area, of artillery and mortars in the future TES system.

**Topic Question Overall Conclusion:** The army rated each of these questions to be HIGH, except for damage to buildings and structures which were rated as NONE.

**Technology:** JPL SAWE IFS technology will satisfy the Flash, Bang and Smoke of K1, 2, and 3; also, K5, 6, 8, 12, 15 and 16.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| K 4. Simulated ground burst | HIGH |
| K 7. Attrition of vehicle crews | HIGH |
| Need proper sensor and RTCA on crew members and means of removing from play as well as cheating. | |
| K 9. Suppression. | HIGH |
| This has issue of very low cost for suppressive fires. | |
| K 13. Adjustment of fire | HIGH |
| Assume that total system with errors is wanted. JPL SAWE IFS can do now. Need FO error analysis for air burst when he has zero to some elevation above target area. | |
| K 14. Round-for-round-simulation | HIGH |
| This has issue of high cost for cue rounds. RF casualty assessment without cues would cost essentially nothing. | |
| **Technology Development Not Needed:** | |
| K 1. Flash of incoming rounds | HIGH |
| K 2. Bang of incoming rounds. | HIGH |
| K 3. Smoke of incoming rounds | HIGH |
| K 5. Simulated air burst. | HIGH |
| K 6. Attrition of vehicles. | HIGH |
| K 8. Attrition of dismounted troops | HIGH |
| K 12. Real-time casualty assessment. | HIGH |
| Assume that SAWE IFS has technology (acoustic or RF). | |
| K 15. Surprise | HIGH |
| Presence of anything on battlefield has problems in obtaining surprise; however, there are a lot of extraneous people, vehicles, (controllers) present. JPL will not consider. | |
| K 16. Time fidelity for receipt of indirect fire | HIGH |
| This may be a problem with fast movers. | |

**Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** None.

**Technology Development Not Needed For These PRIORITY Ranked Needs:** None.

| | |
|---|---|
| **Needs Eliminated From Consideration:** | |
| K 10. Simulation of damage to buildings. | NONE |
| K 11. Simulation of damage to structures | NONE |

L MINES.

Importance of the following, for the simulation of land mine warfare in future TES systems.

**Topic Question Overall Conclusion:** The Army wants to have both conventional and FASCAM. The JPL MES system will perform essentially what they want. The FASCAM is a new consideration and still an issue.

**Technology:** JPL has concluded that conventional mines can be essentially accomplished by the JPL MES technology; this is not the case for FASCAM; significant technology problems exist. Therefore, the Mines subquestions for conventional and FASCAM are separated and duplicated for each. We need to obtain TES SAG input on the issues as to how they are going to use FASCAM and Threat mine simulations. This was a TES Workshop Issue and the FASCAM still is.

| | JPL Priority For Technology Development |
|---|---|
| Conventional Mines: | |
| Technology Development Needed: | |
| L 7. Simulate the attrition and casualty effects. . . . . | HIGH |
| RTCA Problem with high speed vehicle and warning whistle in SAWE MES. | |
| L 15. Provide real-time casualty assessment on vehicle . . . . . | HIGH |
| Safety and speed of vehicle. | |
| Technology Development Not Needed: | |
| L 3. Replicate the trip mechanism of the mine . . . . . | HIGH |
| L 4. Reproduce detection characteristics of the mine. . . . . | HIGH |
| Assume that metal detector is used (MES has metal for this purpose) and others could be simulated. | |
| L 10. Provide for simulating emplacement of mines. . . . . | HIGH |
| L 13. Provide for simulating breaching operations. . . . . | HIGH |
| L 16. Provides real-time casualty assessment on personnel. . . . . | HIGH |
| Under some conditions a soldier could escape from kill radius because of safety warning whistle time. | |
| L 17. Attrition of any player. . . . . | HIGH |
| If any one player can be attrited than any with PDD can be. | |
| L 20. Threat mine warfare. . . . . | HIGH |
| Any mine body can be simulated, assume inner workings are not within current doctrine to do anything with but destroy explosively in place (cannot disarm). | |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: | |
| L 14. Provide for simulating breaching weapons . . . . . | PRIORITY |
| Can't easily simulate use of explosive breaching devices. | |
| L 19. Mine reuse after using (refurbishment) . . . . . | PRIORITY |
| This has negative cost effectiveness. | |

Technology Development Not Needed For These PRIORITY Ranked Needs:

L 1. Replicate the size of the mine being simulated . . . . . PRIORITY

L 2. Replicate the weight of the mine being simulated . . . . . PRIORITY

L 5. Simulate mines on a one-for-one basis. . . . . PRIORITY

L 6. Simulate mines on a generic basis for AT and AP. . . . . PRIORITY
SAWE MES is Generic.

L 8. Simulate only the overall effects of the minefield . . . . . PRIORITY
Army wants more that simple TES. JPL will not consider this approach as a simpler technological approach.

L 11. Provide for simulating arming of mines . . . . . PRIORITY

L 12. Provide for disarming and retrieval of mines . . . . . PRIORITY

Needs Eliminated From Consideration:

L 9. Provide for simulating the logistics of mines. . . . . NONE
Assume that they can be simulated with paper of logistics in rear area, or TES simulator, or dummy.

L 18. Attrition of only major weapons. . . . . NONE
This is Army choice between players; they want all players.

FASCAM:

Technology Development Needed:

L 3. Replicate the trip mechanism of the mine . . . . . HIGH

L 7. Simulate the attrition and casualty effects. . . . . HIGH
RTCA Problem with high speed vehicle and warning whistle in SAWE MES. However FASCAM simulation may be different.

L 10. Provide for simulating emplacement of mines. . . . . HIGH
Artillery delivery.

L 15. Provide real-time casualty assessment on vehicle . . . . . HIGH
Safety and speed of vehicle if warning whistle is used as with SAWE MES.

L 13. Provide for simulating breaching operations. . . . . HIGH
This is a problem because of high cost of simulating one for one FASCAM mines. The SAWE MES does one on one, but if not fired then recovered as in combat. A FASCAM mine is "never" recovered as they blow in place after some delay to sterilize mine field.

Technology Development Not Needed:

L 4. Reproduce detection characteristics of the mine. . . . . HIGH
When FASCAM is on ground there are two considerations: detection system to cause functioning and mine and counter mine detection system to destroy. We assume that Army will keep same methods as for conventional mines. JPL will not consider further as this is classified information.

L 16. Provides real-time casualty assessment on personnel. . . . . HIGH
Under some conditions a soldier could escape from kill radius because of SAWE MES safety warning whistle time.

L 17. Attrition of any player. . . . . HIGH
If any one player can be attrited than any with PDD can be.

L 20. Threat mine warfare. . . . . HIGH
Any mine body can be simulated, assume inner workings are not within current doctrine to do anything with but destroy explosively in place (cannot disarm).

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:

L 1. Replicate the size of the mine being simulated . . . . . PRIORITY

L 2. Replicate the weight of the mine being simulated . . . . . PRIORITY

L 5. Simulate mines on a one-for-one basis. . . . . PRIORITY
Cost on FASCAM.

L 6. Simulate mines on a generic basis for AT and AP. . . . . PRIORITY
TES FASCAM may have to be more sophisticated future mines.

L 11. Provide for simulating arming of mines . . . . . PRIORITY

L 14. Provide for simulating breaching weapons . . . . . PRIORITY
Can't easily simulate use of explosive breaching devices.

L 19. Mine reuse after using (refurbishment) . . . . . PRIORITY
This has negative cost effectiveness.

Technology Development Not Needed For These PRIORITY Ranked Needs:

L 8. Simulate only the overall effects of the minefield . . . . . PRIORITY
Army wants more that simple TES. JPL will not consider this as simpler technological approach.

L 12. Provide for disarming and retrieval of mines . . . . . PRIORITY
FASCAM not retrieved. A problem of FASCAM TES debris.

Needs Eliminated From Consideration:

L 9. Provide for simulating the logistics of mines. . . . . NONE
Assume that they can be simulated with paper of logistics in rear area, or TES simulator, or dummy.

L 18. Attrition of only major weapons. . . . . NONE
This is Army choice between players; they want all players.

M NUCLEAR/BIOLOGICAL/CHEMICAL.
Importance of incorporating the following into the future use of TES.

**Topic Question Overall Conclusion:**
Army wants essentially what they have in the NBC BTA, except for MOPP level, M26; this could infer that they want to use MOPP as real world or that clothing is instrumented.

**Technology:** The SAWE NBC BTA can supply the technology needed as defined by the TES PNS. The PNS response indicates the need for training at all MOPP levels (Q26) which would require instrumentation to determine proper MOPP level; however, technology for this is available. Thus, the question has no direct technology development issues.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| M 2. Training intended for NBC team skill | HIGH |
| M 4. Integrated N, B, and C training exercise | HIGH |
| M 7. Use NBC warning and reporting systems and procedures | HIGH |
| M 8. NBC monitoring and survey teams. | HIGH |
| M 9. NBC simulation devices used by any individual soldier. | HIGH |
| M 12. Traveling through a simulated contaminated area. | HIGH |
| M 13. Nuclear training should be provided for: Company | HIGH |
| M 13. Nuclear training should be provided for: Squad | HIGH |
| M 13. Nuclear training should be provided for: Platoon | HIGH |
| M 13. Nuclear training should be provided for: Battalion | HIGH |
| M 14. Nuclear simulation should provide for: Rate and total. | HIGH |
| M 14 Nuclear simulation should provide for: EMP/TREE. | HIGH |
| JPL assumes on commo equip only. | |
| M 18. Provide surprise delivery to maneuver elements | HIGH |
| M 20. Persistent decontamination similar to an actual agent. | HIGH |
| M 21. Simulation of non-persistent agent | HIGH |
| M 22. Simulation of persistent chemical agent. | HIGH |
| M 25. RTCA when entering a contaminated area | HIGH |
| M 26. Training in all MOPP levels. | HIGHEST |
| MOPP needs garment sensors beyond mask. Technology is available for this. | |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: | |
| M 17 Contamination transfer: From one area to another | PRIORITY |
| M 17 Contamination transfer: To interiors of vehicles | PRIORITY |
| M 23. Delivery of chemical agents by aircraft. | PRIORITY |
| There is limited aircraft available that can use the spray tank. | |
| M 24. Delivery of chemical agents by indirect fire | PRIORITY |
| Persistent has safety problems. | |

Technology Development Not Needed For These PRIORITY Ranked Needs:

M 1. Training for individual soldier NBC skills alone . . . . . PRIORITY
TES will exercise, not train.

M 6. Different NBC simulant realism according to exercise . . . . PRIORITY

M 10. NBC simulation integrated into the medical . . . . . PRIORITY

M 11. Flash/bang/smoke cues for nuclear events . . . . . PRIORITY

M 14. Nuclear simulation should provide for: Dose rate . . . . . PRIORITY

M 14. Nuclear simulation should provide for: Total dose. . . . . PRIORITY

M 14. Nuclear simulation should provide for: Armor protection. . . PRIORITY

M 15. Simulation of biological toxins. . . . . PRIORITY

M 16. Simulation of biological organisms . . . . . PRIORITY

M 19. Provide surprise Combat Support and CSS. . . . . PRIORITY
Both maneuver and CS and CSS have a safety problem with SPAL for persistent agent. NBC BTA demonstrated technical solution. If maneuver has surprise then CS and CSS will have technology.

Needs Eliminated From Consideration:

M 3. NBC training exercises separately from other training. . . . NONE

M 5. Use of notional units and NBC events . . . . . NONE

M 13. Nuclear training should be provided for: Larger than Bn. . . NONE

N MOUT.

Importance of the TES simulation having the following capabilities in MOUT exercises.

Topic Question Overall Conclusion: The Army wants to exercise in urban environments; however, MOUT is not as important as other types of training--see question A11 response of PRIORITY ranking; this is indicated by having only HIGH as the MOUT priority.

Technology: SANDIA does terrorist training which should have some bearing on this technology. This should be a SAG issue: how much is needed. Should there really be a different approach like: MOUT TES equipment is a complete new set (not part or in addition to TES field).

The response indicates that the future TES should use technology that permits MOUT. But the response to Question A11 is not consistent with MOUT question N response. Assume that response is due to MOUT being a small part of total training needs/requirements. MILES was not designed for MOUT operations and Force on Force never gets hand to hand without being stopped--its not maneuver training at this point.

There are several technology areas for close combat and use of TES systems inside structures that need to be addressed for effective MOUT training.

This was a TES Workshop Issue.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| N 4. Casualties on personnel inside buildings or structures . . . | HIGH |
| N 5. Simulate TES weapons inside of buildings . . . . . | HIGH |
| N 7. Engage through obscurants. . . . . | HIGH |
| N 8. Engage at very close range . . . . . | HIGH |
| N 11. Cues in MOUT: Hit signatures . . . . . | HIGH |
| N 11. Cues in MOUT: Weapon firing. . . . . | HIGH |
| **Technology Development Not Needed:** | |
| N 2. Simulate the protection provided by structures . . . . . | HIGH |
| Only a problem if TES is other than lasers because they can't penetrate hard objects. | |
| N 6. Engage at night. . . . . | HIGH |
| If one can engage during day then can do so at night. | |
| N 10. Emphasize the instrumentation of dismounted troops . . . . . | HIGH |
| N 11. Cues in MOUT: Flash. . . . . | HIGH |
| N 11. Cues in MOUT: Smoke. . . . . | HIGH |
| N 11. Cues in MOUT: Noise. . . . . | HIGH |

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:

N 3. Simulate protection degradation from multiple hits . . . . . PRIORITY

N 9. Simulate attrition from use of explosive charges . . . . . PRIORITY
Problem is structural damage by TES.

N 11. Cues in MOUT: Pellets, dye or colorant to mark hits. . . . . PRIORITY
Safety issues.

N 11. Cues in MOUT: Smoke from burning buildings . . . . . PRIORITY
Safety issues.

Technology Development Not Needed For These PRIORITY Ranked Needs:

N 1. Indication of damage to buildings or other structures. . . . PRIORITY

Needs Eliminated From Consideration: None.

O COMMAND AND CONTROL.

Importance of including command and control elements in future exercises on the TES training battlefield.

Note: Command and Control as used in this question relates to the command and control personnel in the unit being trained or evaluated (the Blue Force), and not to the command and control of the TES exercise. Further, the Red or OPFOR are considered as "training aids" thus JPL assumes that their simulation fidelity can be less.

**Topic Question Overall Conclusion:** Army wants to include the command and control units and individuals in the exercise.

**Technology:** Need automatic (computer) reduction of massive amounts of communications data to useful level--who said what to whom and when--for question O9.

This was a TES Workshop Issue.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: | |
| O 7. Provide TES communications data for AAR . . . . . | HIGH |
| Technology Development Not Needed: | |
| O 1. Instrument command and control elements as targets . . . . . TES would use the same technology and equipment for everyone--a sophisticated PDD. | HIGH |
| O 5. Simulate artillery FO, FAC, FDC, and ALO . . . . . | HIGH |
| O 6. Provide data or video of C&C of play for AAR . . . . . | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None. | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| O 2. Simulate C&C functions one echelon higher. . . . . | PRIORITY |
| O 4. Simulate tactical C&C systems such as TACFIRE. . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| O 3. Instrument C&C elements one echelon higher . . . . . | None |

P COMBAT SUPPORT.

Importance of including Combat Support (CS) and Combat Service Support (CSS) elements in future exercises on the TES battlefield.

Note: The CS and CSS elements are those individuals or units that are assigned or attached to the training unit. They physically are present in the TES exercise and are part of the play.

Topic Question Overall Conclusion: The Army wants all of the CS and CSS elements that can be targets to be instrumented. This would be everyone in a fast deep battlefield TES exercise; it also implies that CS and CSS should have defensive kill capability [small arms (rifle, machine gun), claymore mines, antitank and antiaircraft missiles]. They also need to be issued TES (add on training) equipment for their defensive weapons. They also want to include the efforts of these people in the FonF exercise. In particular logistics and medical. JPL would expect the CS and CCS to be important in the larger TES training exercises, like battalion, which last more than a day and loss of these resources is important to the commander and staff logistic planning.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: | |
| P 9. Provide for problems of damage repair/retrieval. . . . . | HIGH |
| This can be done for real occurrences, but not for exercise simulated damage. This is CS and CSS problem as well as unit personnel. | |
| Technology Development Not Needed: | |
| P 3. Instrument all potential combat support targets. . . . . | HIGH |
| P 5. Provide logistics realism. . . . . | HIGH |
| P 6. Provide for field medical actions. . . . . | HIGH |
| Assume this to be only the natural course of exercise events, but not location of wounds--see response to questions in Attrition (U5) and Casualty Assessment (V4). Medics may need better cues derived from action. NBC BTA has for chemical; other is doable. | |
| P 7. Provide for problems of casualty evacuation. . . . . | HIGH |
| P 8. Provide for problems of resupply . . . . . | HIGH |

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

| | |
|---|---|
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| P 1. Instrument combat support vehicles only. . . . . | PRIORITY |
| P 2. Instrument combat support personnel only . . . . . | PRIORITY |
| P 4. Simulate combat support and CSS elements . . . . . | PRIORITY |

Needs Eliminated From Consideration: None.

Q COMMUNICATION DISRUPTION.

Importance to your organization of including communication disruption in future exercises on the TES training battlefield.

**Topic Question Overall Conclusion:** The TES simulation should be limited to simulating actual disruption of commo channels and RF jamming techniques. They do not want a lot of sophistication in TES such as damage and repair. ;limit it to the commo; and not include other electronic equipment.

**Technology:** The problem is to not interfere with any adjacent military, government or civilian uses; also, TES exercises need commo for safety; and using selected Army frequencies could be done with Army equipment. A better solution since we limit this to commo and not other electronic Radio Frequency Interference (RFI) equipment would be to interfere with the speaker or earphones after the radio reception. For actual RF jamming, Q3, Use actual Army equipment, but probably still can't use this in urban areas; there is probably a security classification question for use of real Army equipment in training exercise. Need Army frequency specific for which technology is available. The NBC BTA has offered a technical solution for NBC effects inside of vehicles using Army commo equipment which can be used.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed: None** | |
| **Technology Development Not Needed:** | |
| Q 1. Provide actual disruption of communications. . . . . | HIGH |
| Q 3. Use actual RF jamming techniques . . . . . | HIGH |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| Q 10. Provide for antenna blowoff and field expedient. . . . . | PRIORITY |
| Q 11. Simulate electromagnetic interference on sights. . . . . | PRIORITY |
| Q 12. Simulate interference on other equipment . . . . . | PRIORITY |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| Q 2. Provide simulated disruption of communications . . . . . | PRIORITY |
| Q 4. Disrupt communications by non-RF methods . . . . . | PRIORITY |
| Q 5. Disrupt only selected channels . . . . . | PRIORITY |
| Q 6. Automatically attrit equipment not protected . . . . . | PRIORITY |
| Q 7. Penalize excessive transmission time . . . . . | PRIORITY |
| Q 8. Simulate communication equipment damage. . . . . | PRIORITY |
| Q 9. Allow simulated repair of equipment/replacement. . . . . | PRIORITY |

**Needs Eliminated From Consideration: None.**

R OPFOR.

Importance of the following OPFOR characteristics which might be used on the training battlefield and which should be considered in the design of future TES:

**Topic Question Overall Conclusion:** Thirteen respondents out of the 129 who responded to this question thought that OPFOR is not necessary; 129 respondents believed that the OPFOR should use threat tactics by ranking it as HIGHEST; the rankings as HIGH indicate that OPFOR should replicate Threat Forces in weapons, clothing

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| R 1. Threat maneuver tactics and doctrine | HIGHEST |
| R 3. VISMODS for OPFOR vehicles | HIGH |
| R 5. Threat weapons characteristics only. | HIGH |
| R 6. Threat weapon performance:. | |
| R 6. Available (unclassified) capability. | HIGH |
| R 7. Simulation of threat target vulnerability:. | |
| R 7. Available (unclassified) capability | HIGH |
| R 8. Threat uniforms. | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: | |
| R 2. Actual OPFOR vehicles. | PRIORITY |
| R 4. Actual threat weapons. | PRIORITY |
| R 6. Threat weapon performance:. | |
| R 6. Latest (classified) capability. | PRIORITY |
| R 7. Simulation of threat target vulnerability:. | |
| R 7. Latest (classified) capability. | PRIORITY |
| Security of classified information in TES unclassified training environment. | |

**Technology Development Not Needed For These PRIORITY Ranked Needs: None.**

**Needs Eliminated From Consideration: None.**

S OBSCURATION.

Importance of the following TES design considerations having to do with obscuration:

**Topic Question Overall Conclusion:** From all of the Army discussion JPL would expect Obscuration to have been ranked higher, i.e., Question S1 should have been rated HIGHEST. Shooting through soft cover requires other than laser technology to simulate the projectile. This becomes troublesome when combined with sensors on platforms (tanks) hidden behind soft cover. Note: JPL considers obscurants to be more than tactically placed smoke; it also includes dust, smoke from exhaust, rain, fog and other weather conditions in which the target is seen but cannot be hit because of simulation limitations.

**Technology:** This was a TES Workshop Issue. The classical solution is to find some way to get simulated shell through smoke (fog, dust, rain, etc.). However, only the IR sight in fog-oil smoke has a good solution. (JPL does not foresee Army using IR defeating smokes in training TES exercises. Can we use range instrumentation for pairing and casualty assessment; would still have to put some type sensor on tank to determine that sight did have target to prevent cheating and accuracy. SAG issue: where does smoke play in addition to instrumented ranges.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| S 1. Shoot through obscurants | HIGH |
| S 3. Shoot through soft cover | HIGH |
| **Technology Development Not Needed:** | |
| S 2. Sight through obscurants | HIGH |
| Use actual device. For IR smokes this is a problem to prevent sight use. | |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| S 4. Provide IR-opaque training smoke | PRIORITY |
| S 6. Simulate delivery of obscurants by artillery | PRIORITY |
| This can be done except for delivery of Smoke by simulated artillery. | |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| S 7. Simulate delivery of obscurants by Chemical Corps units. | PRIORITY |
| Can be done now. | |
| **Needs Eliminated From Consideration:** | |
| S 5. Simulate only the effects of IR-opaque smoke | NONE |

T SIGNATURES.
Importance of the types of TES signatures which should be developed.

**Topic Question Overall Conclusion:** Of the 18 questions 14 ranked as HIGH priority and four were PRIORITY. This indicated the need for TES weapon signatures and cues such as flash, bang and smoke. It should be noted, however, that none were ranked HIGHEST priority. The HIGHEST need was given to kill smoke although some of the devices developed for MILES are not being used for a variety of reasons. Weapon bang and flash were also ranked HIGH.

**Technology:** There is a need for non-pyrotechnic, low cost, safe technology. A WES is one technical approach for signatures. The Army does not use some of the ones developed in the past and have problems using pyrotechnics.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| T 18. Signatures through sight imaging systems | HIGH |
| Need to interface within combat sights. | |
| **Technology Development Not Needed:** | |
| T 1. Signatures as cues for the firer | HIGH |
| T 2. Signatures as cues for the target. | HIGH |
| T 3. Hit flash. | HIGH |
| T 4. Kill smoke | HIGH |
| T 5. Weapon flash | HIGH |
| T 6. Weapon smoke | HIGH |
| T 7. Weapon bang. | HIGH |
| Have weapon Hoffman or WES. | |
| T 9. Burst on target. | HIGH |
| Technology exists for providing cue to the gunner. JPL assumes that because a flashing light is adequate MILES and TES cue for KILL something similar could be provided for near miss, etc. | |
| T 10. Incoming artillery or mortar flash | HIGH |
| T 11. Incoming artillery or mortar bang. | HIGH |
| T 12. Incoming artillery or mortar smoke | HIGH |
| SAWE IFS does all of these. | |
| T 13. Mine flash | HIGH |
| T 14. Mine bang. | HIGH |
| T 15. Mine smoke | HIGH |
| SAWE MES does all of these. | |
| T 16. Different signatures for different weapons | HIGH |
| Assuming that only course differences (like large, medium, and small) are needed. | |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| T 8. Tracers. | PRIORITY |
| T 17. Different signatures for different ammunition. | PRIORITY |

**Technology Development Not Needed For These PRIORITY Ranked Needs:** None.
**Needs Eliminated From Consideration:** None.

U ATTRITION.

Importance of providing for the following attrition in future TES exercises:

**Topic Question Overall Conclusion:** HIGH priority need rankings were given for multiple hits and fratricide; ranking of PRIORITY was obtained for vehicle quadrant hits and impact angle, AAR data for who shot who, and helmet detectors on troops. However, there was no priority given to knowing different hit zones on individuals.

**Technology:** All of the above require additional sensors and computations for RTCA; all are doable with current technology if weapon can be simulated.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| U 1. Multiple levels of hits on vehicles. . . . . | HIGH |
| U 2. HIGHer probability of kill for subsequent hits . . . . . | HIGH |
| U 3. Hit quadrant on a vehicle. . . . . | HIGH |
| U 7. Indication of who shot whom (for After Action Reviews) . . . This is the same as pairing and MILES upgrade will do this. | HIGH |
| U 8. Distinguish/identify friendly kills (fratricide) . . . . . This is the same as pairing and MILES upgrade will do this. There may be a problem if immediate feedback is needed; would this be real effect in combat; i.e., one could stop from the cues. | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: | |
| U 4. The effect on kill probability from impact angle . . . . . | PRIORITY |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| U 6. Head shot on individuals (helmet detectors). . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| U 5. Multiple levels on individuals, such as torso, arm, leg. . . | NONE |

V CASUALTY ASSESSMENT.

Importance of the following types of casualty assessment, in addition to the current near-miss, hit, and kill, that might be used in future TES exercises:

**Topic Question Overall Conclusion:** Army wants to have vehicles (weapons platform) lose their mobility; this has two issues: first, after a "kill" the vehicle cannot move, but could use its weapons; this effect would require hull or platform and weapon systems differentiation which is much more sophisticated than MILES, and second, after a "kill" the vehicle cannot move so as to cheat. The second issue is much more easily accomplished. The vehicle mobility issue and attrition of individual crew members is in agreement. These issues are greater than just tanks; they cover all vehicles--dismounted ground and aircraft. Both require some technology and capability not available in MILES.

JPL Priority For Technology Development

Technology Development Needed:

V 3. Attrition of individual crew members . . . . . HIGH

Need sensors on individuals interactive with weapon platform, and have to have weapon target effects include inside vehicle (like hull penetration location).

Technology Development Not Needed:

V 1. For vehicles, loss of mobility . . . . . HIGH

This is a safety issue and not technology which SAWE MES has addressed. Approach: tie mobility use after "kill" as cheating. This could be tied to the vehicle electrical system, but a motion sensor in the PDD would be more independent and technology is available. There is the question of making weapons have mobility kills when they have little effect on target (example LAW at 100 meters).

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:

V 2. Loss of radio. . . . . PRIORITY

NBC BTA provided a technical solution.

V 4. Casualty assessed automatically by TES instead of cards. . . PRIORITY

This was addressed in NBC BTA and can be done.

V 5. Indication of location, type, and severity of wounds . . . . PRIORITY

Needs Eliminated From Consideration:

V 6. Elimination of controller-assessed kills . . . . . NONE

W INTEROPERABILITY.

Importance of the interoperability of future TES with other Army training systems:

**Topic Question Overall Conclusion:** The Army ranked MILES interoperability as HIGHEST priority. They also want the other field training equipment to be used with TES. The classroom or staff trainers were only PRIORITY ranked as was using TES with other NATO equipment.

**Technology:** JPL assumes that the TES PDD is sophisticated for all engagement systems. This was a TES Workshop Issue.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| W 1. MILES. . . . . | HIGHEST |
| This is a major consideration that has to be worked. Assume that existing weapon simulators will have PIP and will not be replaced by TES. Thus, M60 tank would use MILES until replaced by M1. | |
| W 3. TWGSS, or similar gunnery trainers . . . . . | HIGH |
| W 7. Future new equipment capabilities. . . . . | HIGH |
| Assume that individual weapons simulation approach will provide a system to integrate any in the future. | |
| W 8. Future improvements to current tactical equipment. . . . . | HIGH |
| This would be a PIP in TES. JPL will not consider as a technology that is separate. We hope that the SFA will give a solution that provides a system within which any weapon has an approach, because of similarity to another in the future. | |
| **Technology Development Not Needed:** | |
| W 9. Future threat equipment and capabilities . . . . . | HIGH |
| Has no technology issues; data need to be changed in TES threat weapon simulations. Is same problem as our weapons. | |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| W 2. UCOFT, or similar crew trainers. . . . . | PRIORITY |
| W 5. Test instrumentation . . . . . | PRIORITY |
| This is something that should be addressed by TES, but will not be. We assume that with the above interoperability with prior systems that Test people can perform what is needed for testing. | |
| W 6. Other NATO TES systems such as SIMFIRE or Tallissi . . . . . | PRIORITY |
| Major interface problems. | |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| W 4. ARTBASS, or other staff trainers . . . . . | PRIORITY |
| Don't know how it will be used for TES; however it could be used for a Brigade Slice play at NTC to give more notional information. | |

**Needs Eliminated From Consideration:** None.

X CHEATING.

Importance, in the design of future TES systems, of making it more difficult to cheat:

Topic Question Overall Conclusion: Twelve respondents out of 123 considered cheating to not be important to TES. Ranked as HIGH was better cheat and tamper proof designs and less soldier controls. Ranked as PRIORITY was the capability to indicate that cheating be indicated by TES when it occurs. No one wanted more cheating functions delegated to the controllers. The elimination of MILES keys was ranked as a PRIORITY need.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: | |
| X 2. TES systems should indicate when cheating has occurred . . . | HIGH |
| Have to be able to accurately separate TES malfunctions from cheating. | |
| Technology Development Not Needed: | |
| X 1. Systems should be as cheat-proof as they can be made . . . . | HIGH |
| Not a technology development issue. | |
| X 4. Equipment should be made more tamper-proof . . . . . | HIGH |
| X 5. The number of soldier-operated controls should be minimized. | HIGH |

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

| | |
|---|---|
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| X 3.. Use of MILES-type keys should be eliminated. . . . . | PRIORITY |
| Army thinks keys are OK. Different from what we heard in field. | |
| Needs Eliminated From Consideration: | |
| X 6. More functions should be delegated to controllers. . . . . | NONE |

Y CONTROLLERS.

Importance of the role of controllers in future TES force-on-force exercises:

**Topic Question Overall Conclusion:** Ranked as HIGH priority was the need to decrease the number of controllers and decrease the workload on controllers. Controllers should be used to control the flow of the exercise, and arbitrate problems and disputes. There was no desire to use controllers to assess casualties; this correlates with having TES automatic real time casualty assessment.

**Technology:** These are all policy issues and not technology development. This was a TES Workshop Issue. AAR was also a TES Workshop Issue.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| Y 1. Control the flow of the exercise . . . . . | HIGH |
| Y 2. Arbitrate problems and disputes as referees. . . . . | HIGH |
| Y 5. Prevent cheating . . . . . | HIGH |
| Y 6. Emphasis should be to decrease the number of controllers . . | HIGH |
| Y 8. TES should reduce the workload on controllers. . . . . | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None. | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| Y 3. Evaluate trainees. . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| Y 4. Assess casualties. . . . . | NONE |
| Y 7. More use of controllers from other than combat units . . . . | NONE |

Z POSITION LOCATION.

Importance of having player position location for exercise control and After Action Reviews:

**Topic Question Overall Conclusion:** Army ranked HIGH the use of position location equipment for only major weapons and while engaging as being of any importance. This will simplify TES. They also discounted any importance to weapon or vehicle orientation. For air weapons they saw no use for the altitude. If location information were available 10 to 100 meters would be adequate.

**Technology:** This response indicates that the Army has no need for dismounted individual PLS; Z2 and Z11 have technically been done (NTC). This was a TES Workshop Issue. A SAG issue is where location of weapons (Z2) is needed.

JPL Priority For Technology Development

Technology Development Needed: None.

Technology Development Not Needed:

Z 2. Location of major weapons only (tank, TOW, etc.) . . . . . HIGH
This is not a problem for Major Areas like NTC, but is for any smaller. IT IS A SAG ISSUE for un-instrumented ranges.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:

Z 11. Location needed only when engaging (or being engaged). . . . PRIORITY
Need to eliminate data from data sets. This implies pairing.

Needs Eliminated From Consideration:

Z 1. Location of every player . . . . . NONE
Z 3. Location of all but dismounted individual troops . . . . . NONE
Z2 and Z3 provides separation of PLS.
Z 4. Location to within 100 meters. . . . . NONE
Z 5. Location to within 10 meters . . . . . NONE
Z 6. Location to within 1 meter. . . . . NONE
Questions Z4, 5, and 6 did not have any PRIORITY need indicated in Army PNS response. However, PNS had separation: don't need to 1 meter, and could use 10 to 100 meters; NTC system has 10 meter capability.
Z 7. Include altitude as well as X, Y coordinates . . . . . NONE
Z 8. Include orientation of vehicle . . . . . NONE
Z 9. Include orientation of weapon. . . . . NONE
Z 10. Location continuously updated. . . . . NONE

AA INTERVISIBILITY.

Importance of including intervisibility instrumentation in future training exercises:

**Topic Question Overall Conclusion:** Twenty six respondents did not think that intervisibility was important to Force on Force (FonF) training. Of those ranking the questions the major weapons should know when another weapon is visible. PRIORITY was the rank used for other players. This data would be used by controllers.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| AA 2. Include intervisibility only for major weapon systems. . . . Need weapon target TES commo. | HIGH |

**Technology Development Not Needed:** None.

**Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:**

| | |
|---|---|
| AA 1. Include intervisibility in all levels of training. . . . . | PRIORITY |
| AA 3. Provide intervisibility as a option only for gunnery . . . . | PRIORITY |

**Technology Development Not Needed For These PRIORITY Ranked Needs:** None.

**Needs Eliminated From Consideration:** None.

BB DATA COLLECTION.

Importance of providing increased capability for the collection of engagement data during future exercises on the TES training battlefield:

Topic Question Overall Conclusion: There were no HIGHEST or HIGH ranking for TES data collection; we can conclude that they feel that data collection is not very important for TES to accomplish. Of greater importance is the data of what weapon fired on what target.
Technology: There was consensus that they desired automatic data collection and would trade-off simplified TES equipment.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed: None.** | |
| Technology Development Not Needed: | |
| BB 8. Include firing weapon ID in the data sent to the target. . . Upgraded MILES does this. | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: | |
| BB 3. Provide for real-time display or transmission of TES data. . | PRIORITY |
| BB 7. Include player position location in TES instrumentation. . . This does agrees with Question Z. | PRIORITY |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| BB 2. Provide on-board storage of some engagement data . . . . . Need readout and use interface. | PRIORITY |
| BB 4. Provide video taping of overall maneuver areas . . . . . | PRIORITY |
| BB 6. Provide computer graphics for After Action Reviews . . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| BB 1. Simplify equipment by minimizing automatic data collection . Army wants TES to do more than MILES. | NONE |
| BB 5. Provide video taping of sight pictures . . . . . | NONE |

CC SIZE.
Importance of equipment size in the design of future TES systems:

**Topic Question Overall Conclusion:** TES should be smaller than MILES. This should be able to be accomplished, and that TES equipment should be smaller so that it is more transparent to troops. They also desire to keep helmet detectors even though the present MILES system is difficult to use.

**Technology:** There are no technology issues with size.

JPL Priority For Technology Development

Technology Development Needed: None.

Technology Development Not Needed:
CC 1. Future TES should be smaller than MILES. . . . . HIGH
Assume that microelectronics will provided. Problem is with battery power.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:
CC 3. Reduce size to improve transparency to the user. . . . . PRIORITY

Technology Development Not Needed For These PRIORITY Ranked Needs: None.

Needs Eliminated From Consideration:
CC 2. Size is more important than increased capability . . . . . NONE
CC 4. Eliminate helmet detectors and associated electronics. . . . NONE
This is negative question: they want helmet instrumented. From the complaints the we heard about the new helmet and MILES the package should be improved by making it fit the new helmet (PIP). There is also the question of battery power on size.

DD WEIGHT.
Importance of weight in the design of future TES systems.

**Topic Question Overall Conclusion:** The weight of TES equipment carried by infantry should be less than two pounds was ranked as HIGH. Less than 10 pounds was ranked as PRIORITY. At some weight between 10 and 20 pounds the effect is to have negative training value. For helicopters the weight of TES equipment should be less than 50 pounds. The same response was made for fixed wing aircraft.

**Technology:** The response indicates that the future TES should use technology that permits low weight equipment, but this question has no direct technology development issues.

| | JPL Priority For Technology Development |
|---|---|
| Technology development needed: None. | |
| Technology Development Not Needed: | |
| DD 1. Maximum for infantry must be: Less than 2 pounds . . . . . | HIGH |
| DD 2. Maximum on a helicopter must be: Less than 50 pounds . . . . | HIGH |
| DD 3. Maximum on a aircraft must be: Less than 50 pounds . . . . . | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None. | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| DD 1. Maximum for infantry must be: Less than 10 pounds. . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| DD 1. Maximum for infantry must be: Less than 20 pounds. . . . . | NONE |
| DD 2. Maximum on a helicopter must be: Less than 200 pounds. . . . | NONE |
| DD 3. Maximum on a aircraft must be: Less than 200 pounds. . . . . | NONE |

EE TYPE OF ELECTRICAL POWER.
Importance of the source of electrical power for future TES systems.

**Topic Question Overall Conclusion:** TES should use vehicle power whenever possible, and battery use should be minimized--this would indicate the desire to eliminate the need for replacement of electrical power source. There was no desire for TES to use commercial batteries or high density power sources such as the lithium cell. Rechargeable batteries were given a PRIORITY ranking.

**Technology:** This question has no direct technology development issues if we assume the lithium battery problem will be solved and TES can use.

There seems to be a conflicting answers in battery power; JPL assumes that the current methods or technology are suitable, but most of the weight and performance problem is centered around providing adequate operation times (96 hours in cold weather) with current batteries.

JPL Priority For Technology Development

Technology Development Needed: None.

Technology Development Not Needed:
EE 1. Use of vehicle power whenever possible . . . . . HIGH
Technology of having clean, conditioned power for EMI sensitive TES electronics is available.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:
EE 4. Use rechargeable batteries . . . . . PRIORITY
EE 5. Minimize use of batteries. . . . . PRIORITY
EE 6. Provide longer power duration than MILES . . . . . PRIORITY

Needs Eliminated From Consideration:
EE 2. Use of special high performance batteries. . . . . NONE
EE 3. Use standard commercial batteries. . . . . NONE

FF BUILT-IN TEST (BITE).

Importance of the types of Built-In Test Equipment (BITE) that should be included as part of future TES systems:

**Topic Question Overall Conclusion:** Eighteen respondents felt that BITE was not important to TES. Of those ranking the questions--109 to 115 respondents, they ranked the ability of the user to use BITE as PRIORITY which indicates that BITE is not very important to the Army. However from the small details: they want BITE operable by user over BITE for repair personnel (FF1 and FF2); it should be automatic (FF3); also they want to know what component is bad (FF5) at the system level, and what's wrong with the component (FF6).

**Technology:** This question has no direct TES technology development issues; first it can be done with current technology for all but readout, and second all are just PRIORITY.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: None. | |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None. | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| FF 1. BITE operable by user. . . . . | PRIORITY |
| FF 2. BITE operable by repair personnel only . . . . . | PRIORITY |
| FF 3. Activates automatically. . . . . | PRIORITY |
| FF 4. System-level BITE (Go/no go only). . . . . | PRIORITY |
| FF 5. System-level BITE (which component is bad) . . . . . | PRIORITY |
| FF 6. Component level BITE (what's wrong). . . . . | PRIORITY |
| Needs Eliminated From Consideration: None. | |

GG INSTALLATION.

Importance of the following, relating to the installation of future TES equipment:

**Topic Question Overall Conclusion:** TES equipment installation was ranked as HIGH. It should be easier to install than MILES and be able to be installed by military personnel in the field. There was no desire to have more permanent installation. The use of civilian personnel was not considered desirable.

**Technology:** This question has no direct technology development issues.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed: None.** | |
| **Technology Development Not Needed:** | |
| GG 2. Much easier to install than MILES. This is just an engineering design problem. | HIGH |
| GG 4. Installation anywhere in the field | HIGH |
| GG 6. Installation by military personnel | HIGH |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.** | |
| **Technology Development Not Needed For These PRIORITY Ranked Needs:** | |
| GG 5. Installation by civilian personnel | PRIORITY |
| **Needs Eliminated From Consideration:** | |
| GG 1. More permanent installation. | NONE |
| GG 3. Installation at a TES installation facility. | NONE |
| GG 7. Installation by specialists. | NONE |

HH ISSUE.

Importance of the following in the warehousing and issue of future TES equipment:

**Topic Question Overall Conclusion:** The highest ranking was PRIORITY; thus the issue of TES equipment was not considered to be a major problem; this probably comes from their experience with MILES. However, each battalion should have enough TES equip a platoon size unit. TES should have test and checkout equipment and be designed for two man carry. There was agreement that issue by TASC was not the best way.
It was felt that soldiers having TES equipment would be negative training, and that expendable TES equipment was not desirable.

Technology: This question is policy related and has no direct technology development issues.

JPL Priority For Technology Development

Technology Development Needed: None.

Technology Development Not Needed:
HH 2. Future TES should be resident in the battalion . . . . . HIGH
TASC is not what is wanted. Not a technology issue.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:
HH 4. TES equipment issued should be boxed for two man carry . . . PRIORITY
HH 6. TES equipment sets should include test equipment . . . . . PRIORITY
JPL will not consider.
HH 7. Each battalion should have TES equipment for a platoon . . . HIGH
Not a technology issue except for cost.

Needs Eliminated From Consideration:
HH 1. Some components should be kept by each soldier . . . . . NONE
HH 3. Future TES should be issued from TASC as it is now . . . . . NONE
HH 5. Emphasis should be placed on expendable devices. . . . . NONE

II MAINTENANCE.

Importance of the following in the maintenance of future TES equipment:

**Topic Question Overall Conclusion:** Maintenance was not considered very much of a problem; it ranked only PRIORITY for any one question. However, TES should be designed so that it can be repaired in the field by the using unit. The component repair by TASC was the preferred priority approach.

**Technology:** This question relates to policy and has no direct technology development issues.

| | JPL Priority For Technology Development |
|---|---|
| Technology Development Needed: None. | |
| Technology Development Not Needed: | |
| II 1. Components designed for maximum serviceability in the unit . | HIGH |
| II 3. Component replacement in the field . . . . . | HIGH |
| II 6. Repair by military personnel . . . . . | HIGH |
| Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None. | |
| Technology Development Not Needed For These PRIORITY Ranked Needs: | |
| II 2. TES designed for easy fault isolation: By TASC . . . . . | PRIORITY |
| II 2. TES designed for easy fault isolation: By troops . . . . . | PRIORITY |
| II 4. Component replacement by TASC. . . . . | PRIORITY |
| II 5. Component repair by TASC . . . . . | PRIORITY |
| II 7. Repair by civilian personnel . . . . . | PRIORITY |
| Needs Eliminated From Consideration: | |
| II 2. TES designed for easy fault isolation: By CLS only . . . . . | NONE |

JJ TES EQUIPMENT TRAINING.

Importance of providing for the following training in the use of future TES:

**Topic Question Overall Conclusion:** None of the questions were ranked higher than PRIORITY; those were: use TES in basic training and provide videotapes, TES training should include information on its limitations, and controllers need some additional training aids for their use.

**Technology:** This question is related to training policy has no direct technology development issues. It seems that what we heard about MILES training can be solved by MILES type of technology and additional effort is not needed in TES.

JPL Priority For Technology Development

Technology Development Needed: None.

Technology Development Not Needed: None.

Technology Development Needed But PRIORITY Ranking Is To Low To Pursue: None.

Technology Development Not Needed For These PRIORITY Ranked Needs:

| | |
|---|---|
| JJ 1. Introduction to TES as part of basic training. . . . . | PRIORITY |
| JJ 2. Expand to include the limitations inherent in simulation . . | PRIORITY |
| JJ 3. Expand to include maintenance and fault isolation. . . . . | PRIORITY |
| JJ 4. Provide more training aids for the installation of TES . . . | PRIORITY |
| JJ 6. Provide videotapes for TES training. . . . . | PRIORITY |
| JJ 8. Provide training aids for controllers. . . . . | PRIORITY |

Needs Eliminated From Consideration:

| | |
|---|---|
| JJ 5. Provide more training aids for maintenance of TES. . . . . | NONE |
| JJ 7. Provide simulators for classroom/dayroom training. . . . . | NONE |

KK **TARGETS.**
Importance of having TES instrumentation for live fire targets:

**Topic Question Overall Conclusion:** This question deals with the use of TES concepts for live fire targets. The ranking indicated that the targets should be more realistic of maneuver engagement. Ranked as HIGH priority were hit sensors and cues, real time casualty for near miss, hit or kill, and adjustment of kill probability with prior hit damage. Also shootback targets. The need for paring data was ranked only as PRIORITY.

**Technology:** The response indicates that the future TES should use technology that permits TES instrumented targets for live fire; part of this is being done now (TWGSS). This question has no direct future TES technology development issues except for unmanned TES targets (OPFOR) where automatic shootback would be possible need. If future TES has pairing then the targets will also have this technology available. Use of TES during live fire exercise implies potential for less use of live fire ammo and more integrated training during live fire. There are some questions for Army as how they would use and integrate live fire with TES equipment; what weapons etc. Should assume that tanks are of importance now, but that if tanks get it then other weapons will want the same capability. It's all part of gunnery and TES integration.

| | JPL Priority For Technology Development |
|---|---|
| **Technology Development Needed:** | |
| KK 3. Targets with capability for simulated shootback. . . . . This is a BIG technology Problem. | HIGH |
| **Technology Development Not Needed:** | |
| KK 1. Cues to indicate hit or near miss or kill. . . . . Assume that coded flashing light technology is suitable. | HIGH |
| KK 2. Hit sensors on targets . . . . . Assume same as for TES. | HIGH |
| KK 4. RTCA for near miss, hit, or kill of targets. . . . . | HIGH |
| KK 5. Probability of kill adjusted for number of hits on target. . | HIGH |
| KK 8. Weapon and target pairing data when a hit is accomplished . . If we can pair when hit then we can pair at any time there is commo between target and weapon. MILES upgrade will identify target and weapon, but SAG needs to clarify when and how information will be used. | HIGH |
| **Technology Development Needed But PRIORITY Ranking Is To Low To Pursue:** | |
| KK 6. Weapon and target pairing data when a target is observed . . | PRIORITY |
| KK 7. Weapon and target pairing data when a weapon is fired. . . . | PRIORITY |

**Technology Development Not Needed For These PRIORITY Ranked Needs:**

**Needs Eliminated From Consideration:** None.

# APPENDIX D

## SECTION 4

## WORKSHOP REPORT
## TECHNOLOGIES FOR FUTURE GENERATION TES

7070-73

# WORKSHOP REPORT

# TECHNOLOGIES
## FOR
# FUTURE GENERATION
# TACTICAL ENGAGEMENT SIMULATION (TES)

**JUNE 1987**

Prepared for
**Department of the Army**
**Project Manager, Training Devices**

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A Report on the JPL Workshop
of 21-22 April 1987

## 1. INTRODUCTION AND PURPOSE

For some time the Jet Propulsion Laboratory (JPL) has been under contract to the U.S. Army Program Manager, Training Devices (PM-TRADE) for the development of a system for the Simulation of Area Weapons Effects--Indirect Fire Simulation (SAWE-IFS) for use in tactical engagement training. Having achieved a successful SAWE proof of concept, and thus demonstrated their capability to apply high-technology to Tactical Engagement Simulation (TES), JPL was tasked by PM-TRADE "...to provide the Army with a report that describes the technology development programs that will be needed to support future-generation Tactical Engagement Simulation systems." In pursuit of this task, JPL convened a Workshop involving JPL consultants and staff at the California Institute of Technology on 21-22 April 1987, specifically charged with:

a. Suggesting technological approaches that might be used to solve specific TES issues presented by JPL.

b. Identifying those current technologies that are not yet mature but that should be supported by the Army to ensure success of future generation TES.

The full text of the Workshop Charter is included as Appendix A. The list of Panel Members and other Workshop attendees is given in Appendix B.

Since it is most relevant to identify the promising technologies in the context of simulation for training, the main question posed to the Workshop was: "Where should we (JPL) go from here in the development of TES systems?" This question was interpreted to encompass technologies not only for new TES systems concepts and applications, but also for improvements designed to enhance the realism, fidelity and effectiveness of such existing TES systems as the Multiple Integrated Laser Engagement System (MILES) and SAWE (to be described below).

To provide a common framework, the Workshop conferees were exposed to a morning of briefings by JPL personnel (see Appendix C, Workshop Agenda), including a summary sketch of preliminary responses to a questionnaire soliciting suggestions and comments for simulation developments from various Army commands. Coming from

a diversity of sources, these responses provided a rather fragmented overview of either the problems or the opportunities of Tactical Engagement Simulation. Accordingly, a substantial fraction of the Workshop time and effort was devoted to the development of an overview and perspective to provide a foundation from which logical extensions of Tactical Engagement Simulation might be projected.

To this end, the Background (Section 2 of this report), is followed in Section 3 by a general description of training objectives, environments and methods as we perceive them. Section 4 then analyzes the need for simulation in training. This is followed in Section 5 by a discussion of TES requirements, constraints and limitations. Section 6 attempts to set forth some general criteria to help guide the selection of simulation areas to be addressed. Section 7 highlights several simulation problems, together with opportunities and conceptual ideas contributed by the Panel members. Finally, Section 8 addresses some aspects of the relationship of the training environment to the real battlefield, and particularly the possibility that battlefield deficiencies revealed in training could be used to improve not only training but also actual battlefield capabilities.

It must be emphasized that this report is based upon less than one full day of discussions of the Panel as a group. Over a period of some weeks after the meeting, several members submitted papers elaborating upon certain of the subjects and concepts summarized in Section 7. Since JPL did not sponsor a follow-on meeting, there has been no opportunity for the group to discuss these papers and approve or modify them for adoption by the committee as a whole; it thus seemed best to include them in this report as a series of stand-alone annexes, each under the name of its respective author. This separation from the body of the report is not to be considered lack of consensus, but rather lack of opportunity to assess consensus.

## 2. BACKGROUND

In recognition of the potential of simulation devices in troop training, the Army some years ago established within the Army Materiel Command the Project Manager, Training Devices (PM TRADE), now located in Orlando, Florida. Over the last decade, this organization has sponsored the development of numerous devices for training in the use and maintenance of various Army equipment--vehicles, major weapons systems, etc. More recently, PM TRADE has addressed the problem of Tactical Engagement Simulation (TES) particularly through the development of two systems:

a. The Multiple Integrated Laser Engagement System (MILES);

b. The Simulation of Area Weapons Effects--Indirect Fire Simulation (SAWE-IFS) system.

MILES is designed for training in two-sided engagement field exercises. It utilizes a "weapon" that emits a (weak and nonhazardous) laser pulse that can be aimed at "enemy" infantry personnel, vehicles, etc., and thus can simulate direct-fire, line-of-sight weapons such as rifles and machine guns. The targets, both personnel and vehicles, are fitted with appropriate harnesses bearing several laser-pulse sensors together with the electronics, batteries, etc., necessary to register and signal a "hit." In these training exercises, referees keep score and ensure that personnel and equipment knocked out are thereafter removed from play. Evidently, the learning imparted in such exercises concerns the minimization of casualties and vulnerabilities to direct fire: the value of low profile, cover and concealment, protective earthworks, rapid transit through exposed terrain, etc.

MILES, however, has several important shortcomings: any opaque cover, however superficial, stops the laser pulse even though it would not afford protection from a rifle bullet; the penalty for being "hit" is purely mental (the "disgrace" of being removed from the game); various opportunities exist for cheating (e.g., covering up the sensors); and the simulation is limited to direct-fire, line-of-sight engagements.

The MILES technology is now being applied in several related [1] simulation developments:

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[1] Brief descriptions of the various simulation devices in use or under development by the U.S. Army are contained in a Five-Year Training Devices Plan issued and updated annually by U.S. Army Forces Command (FORSCOM). The table of contents of this FORSCOM Pamphlet 350-15, dated 1 January 1987, is reproduced in Appendix D. (Note that FORSCOM is the user, TRADOC the developer of these training devices.)

a. The Multiple Integrated Laser Engagement System (MILES), Air Ground Engagement System (AGES)/Air Defense (AD), is a family of laser engagement systems compatible with the basic MILES. It consists of MILES AGES components to enable helicopters (UH60, OH58P, and AH64 and CH47) to participate in combined arms tactical training. Program objectives are to provide a realistic means of simulating: (1) helicopter operations during the course of tactical training; (2) ground-to-air defense measures against low performance aircraft during the course of tactical training; and (3) inclusion of real-time casualty assessment in combined arms exercises incorporating air-to-ground and ground-to-air weapons systems. Air-to-ground weapons include TOW, 20mm Machine Gun and 2.75-inch rockets.

b. The Tank Weapons Gunnery Simulation System (TWGSS) interfaces with the tank fire control system and permits simulated, precision main-gun firing. Lead, superelevation, range, and ammunition will be considered during an engagement. A simulated tracer and impact indication will be superimposed in the sight. Obscuration at firing, sight displacement, and target effects will be simulated. A crew-evaluation subsystem will be included to provide a hard-copy record of the engagement. It will enable the trainer to reconstruct the firing sequence for tank-crew evaluation and critique purposes. TWGSS is compatible on ranges which have Armor Remoted Target Systems. It can also be used with MILES and will interface with the Eye-Safe System Laser Rangefinder (ESSLR) for tanks with a laser rangefinder. (Further discussion of TWGSS is contained in Annex E.)

c. The Simulation of Area Weapons Effects - Indirect Fire Simulation (SAWE-IFS) system, developed by the Jet Propulsion Laboratory under contract to PM TRADE, is designed to extend TES development beyond the direct fire, line-of-sight MILES to engagements involving indirect fire, area weapons, such as artillery. SAWE-IFS uses a miniature, mortar-like projectile, launched from an air-pressurized tube and carrying a small explosive charge that generates an airburst flash/bang/smoke signature when detonated by its time fuze. This signature is used to indicate to the trainees (and referees) on the ground that the area immediately below the air-burst point is under artillery fire. An acoustic cue generated by the airburst will be converted into a MILES-compatible code that is sensed and transmitted to the standarddirect fire MILES detector/processor to provide automatic casualty assessment.

As with MILES, the SAWE-IFS technology is being extended in related simulation developments:

d. Simulation of Area Special Effects Weapons--Mine Effects Simulator (SAWE/MES) is a simulation of the M15AT, M16AP mines that are MILES interoperable. The devices will conform to the external configuration of the mines and will be detectable by the AN/PSS-11, AN/PRS-7 mine detectors. The device will have a flash/smoke signature and will acoustically cue the MILES system through the Player Detector Device (PDD) to provide real-time casualty assessment (RTCA). The SAWE-MES will consist of three components: a body (M15AT and M16AP), an actuator, and an energy cartridge containing black powder. The energy cartridge will have a Class V (Ammunition) supply classification and will be transported, stored, and handled as an ammunition item. The packed and crated energy cartridge will be stored at Class V supply points. The SAWE-MES body and actuator will be handled as a training device and can be stored and distributed through the TASC.

A more global and ambitious approach is contained in:

e. The Mobile Automated Field Instrumentation System (MAFIS) being developed under the aegis of the U.S. Army Training & Doctrine Command (TRADOC). MAFIS is a distributed instrumentation system comprised of three principal subsystems: Command & Control, Field Instrumentation and Operational Support. The MAFIS Universal Field Element (UFE) is intended to be highly proliferated and widely distributed to the individual players. It contains modules for position location, logic and communications that tie into the centralized Command & Control system. Although MAFIS is designed principally for testing of the effectiveness of Army weapon systems and doctrine rather than for training per se, it clearly could provide enormous opportunities also for training, including simulation. MAFIS is one example of the great potential of digital data links, whose exploitation is discussed in Section 7.3. Many of the remarkable developments in solid-state electronics, sensors, etc., described in Annex A, may help bring such large and complex systems from the conceptual stage to actual reality.

## 3. TRAINING OBJECTIVES, ENVIRONMENTS AND METHODS

The goal of military training is to field combat units that can operate effectively and efficiently in combat. To achieve this goal the Army uses a variety of training methods and conducts training for groups ranging from individuals to units in environments that have progressively more elements common to the battlefield. Table 1 lists the common trainee groups and applicable methods used in training.

Table 1. TRAINEE GROUPS AND TRAINING METHODS

| Trainee Group | Instruction | | | | Practice | | |
|---|---|---|---|---|---|---|---|
| | Lectures | Handbooks, Manuals | Video, Film | Demo | Hands-on | Range | Field |
| Individua | X | X | X | X | X | X | -- |
| Crew | X | X | X | X | X | X | -- |
| Unit | X | X | X | -- | -- | -- | X |
| Force-On-Force | X | X | X | -- | -- | -- | X |

Most simulators and other types of training devices, including actual equipment, are used for instruction and individual and crew practice. Their principal requirement is to highlight features important to the training objectives and allow manipulations equivalent to those required in use or maintenance of the real items.

Of concern in TES, however, are simulation devices used for field training, where, in addition to the manipulative realism of the simulated device, simulated effects of the device must also be produced. In some instances the concern is only to simulate the effects and not require realistic individual or crew operations to work the device in the same manner as the actual equipment. The SAWE-IFS system previously described is an example of this latter type of simulator. The need for such devices is a natural outgrowth of the desire to improve the simulations of comprehensive, realistic combat engagements and environments for force-on-force training, i.e., Tactical Engagement Simulation.

TES, conducted at the U.S. Army National Training Center (NTC), Ft. Irwin, California, provides field training for unit and force-on-force groups. TES brings together the interactive effects of equipment, weapons, the tactical actions of friendly and enemy forces, and the physical environment. Team and unit skills are

developed. Individual soldiers and crews also benefit by having the opportunity to practice skills learned in a home-base environment in situational milieus that impose a new set of demands, and, consequently, extend and transform the basic skills to opertional combat skills.

Other individual beneficiaries of TES are the unit leaders and commanders whose primary skills cannot be practiced except in the force-on-force context. Classroom instruction on tactical theory can be pragmatically implemented, and tested, in TES. The leader must select from the many tactical lessons that looked good on a blackboard and decide which are applicable to the present problem. Learning from the consequences of decisions occurs in a vivid manner. Overrunning/routing the opposing forces or loss of ground troops and material are instances of positive and negative feedback for lessons learned that are not likely to be soon forgotten. If the objective was only realistic training for leaders, and not training of all participants, the NTC could use hired civilians to play parts rather than use actual soldiers.

Although the main objective of this report is to discuss technology to improve TES for training purposes, it should be noted that TES also provides opportunities for benefits to the Army in addition to training soldiers, units, and unit leaders.

Training methods can be evaluated. For example, comparison of the performance of individuals, crews and units that have received different types or lengths of training will lead to more efficient training and more highly skilled soldiers. Present evaluation methods are not nearly as reliable as results from a TES. Moreover, home-based training, i.e., classroom instruction, demonstration and practice with actual equipment or training devices, can be evaluated for transferability to the realistic combat environment of TES. Performance results from combat will be useful to officers responsible for training, ranging from TRADOC and branch Directors of Training Developments to unit commanders having responsibility to implement Army Training and Evaluation Program (ARTEP) requirements.

Perhaps an even more valuable benefit afforded by TES is the capability to use engagement data to evaluate and validate equipment, tactics and doctrine. A critical part of an engagement simulation exercise is the After Action Review, where all participants have a place to tell their story and significant learning takes place. When TES occurs between well trained forces, the engagement outcome is substantially independent of variation in individual and unit performance. Instead, engagement outcomes reflect on the efficiency of the equipment and tactics to defeat a defined threat or accomplish the mission goal. However, nothing must interfere with the training objectives of the exercise.

## 4. THE NEED FOR SIMULATION IN TRAINING

Training with real equipment and the requisite repetitive trials can be very costly, particularly where expendables are used (e.g., artillery, shells, tank fuel, wear & tear on vehicles). Moreover, although battles produce casualties to both equipment and personnel, the realism of the training must stop short of destructive testing of expensive equipment or injuring the trainees (although it is reported that Soviet military training, for example, in a chemical-warfare exercise, has resulted in actual deaths).

There are five primary factors that drive military training toward the use of simulation:

a. Safety.
b. Cost of expendables.
c. Wear and tear on expensive equipment.
d. Need for many repetitive trials and continuous proficiency update.
e. Increased effectiveness over real equipment.

The Army draws a distinction between two broad classes of training devices:

a. System devices are defined as those developed tosupport a particular material system, such as the M1 Unit Conduct-of-Fire Trainer.

b. NonSystem* devices are those developed to support general military training, training on two or more systems, or on several different types of equipment.

Given that complete realism is inaccessible in simulation, a critical issue is the priority listing of the various aspects of the real situation to be simulated.

To achieve the strongest possible interaction with the trainee, training must always involve communication through the individual's five senses--of which the two most important are visual and auditory. Depending upon the training to be accomplished, communication with the trainee can utilize several different approaches:

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*Note that the "nonsystem" training devices generally have broader application than the "system" devices, and are thus closer to what is usually meant by the (overall) systems approach, as in systems analysis.

a. Data only. Displays on radar, TV or computer screens; instrument readings; and audio signals through speakers or earphones. In the Military Operations Specialties (MOS) to which this is appropriate, the trainee is essentially isolated and insulated from the outside world by various intermediary devices (e.g., computer displays, audio systems) that provide visual and audio data that can obviously be accurately simulated. Thus the training of air-defense radar operators against massive air raids can be carried out with only few real intruder aircraft, but with the tracks of many others being simulated by tape input in such a way as to be indistinguishable to the radar operator from genuine tracks.

b. Physical effects. Inertial effects in flight simulators (e.g., Device 2B24, the UH-1 instrument trainer); the flash, bang and shockwaves from explosions; the freight-train sound of incoming artillery; the siren-like Doppler whistle of spinning rockets passing overhead; the creation of artillery-shell craters; the sudden wounding or even disintegration of adjacent buddies; the call for Medics; etc. In the present development state of simulation devices, very few of these physical effects are simulated in any form, much less realistically.

c. Symbolic cues. Effects of surrogate devices that provide symbolic signatures or effects which the soldier is trained to interpret in certain ways. MILES utilizes a buzzer to inform the trainee that he has been "hit" and is thereafter out of action. Similarly, the SAWE-IFS system uses the aerial flash/bang/smoke of a small explosive charge to simulate an attack by artillery on the ground forces near the nadir. In field exercises, both MILES and SAWE-IFS rely on the individual to "play the game" with the prescribed interpretation of the symbolism.

d. Psychological realism. Lacking the realism of a life-and-death situation (the frightening crack of shockwaves or eerie whine of ricochets from near-miss bullets, the clang of high velocity fragments against an armored hull), those battlefield aspects perhaps most difficult to simulate are the psychological effects that help motivate learning. A brief analysis of the factors that enhance motivation and stress, and how their simulation can lead to more realistic and effective training is contained in Annex D.

## 5. TES REQUIREMENTS, CONSTRAINTS AND LIMITATIONS

Since it is impossible and even undesirable to achieve complete realism in tactical engagement training, the question arises as to which aspects should be simulated and in what order of priority. Safety requirements are properly assigned high priority, and dictate that troops not be exposed to potentially lethal fire. Thus, the fire from small arms (rifles, machine guns) was a high priority candidate for simulation, and resulted in the development of MILES. Similarly, the SAWE-IFS system was developed as a surrogate for artillery fire.

Pursuing this theme, inclusion of attack by air (e.g., close air support) as a step towards tactical engagement training in combined arms operations will evidently require some nonhazardous simulation of air-delivered ordnance. This might be an off-shoot of the SAWE-IFS development: a single aerial explosion to represent a unitary bomb, and numerous simultaneous but smaller explosions over a substantial area (e.g., the size of a football field) to represent a cluster bomb unit (CBU). It is noteworthy that helicopters are capable of carrying not only machine guns and rockets, but also bombs; and that, although the assignment of roles and missions among US Services precludes Army helicopters from delivering bombs, no similar constraint may exist for adversary helicopters.

Other lethal weapons that may require simulation surrogates include mines of various sorts, hand grenades, grenades from grenade launchers (such as the Army's M/79), etc. Some simulation approaches for these weapons are discussed in Section 7.

As the sophistication of tactical engagement training increases (e.g., through the inclusion of ground and air combined arms) specific interactions may become critically important to simulate: air-ground and ground-air interactions inherent between aircraft and air defenses, and between close-air-support aircraft and friendly ground troops; and the impact of close-in and stand-off jamming on intra-unit communications and inter-unit communications to adjacent forces, higher command echelons, support forces, and joint elements.

With respect to the three objectives of field exercises discussed in Section 3, essential TES capabilities in <u>training</u> include exercises involving:

a. Two-sided force-on-force engagements.

b. Combined-arms and joint operations.

c. Operations in both natural and disturbed environments.

d. Organic sensors and C3I operations.

e. Both light and heavy forces.

f. Coordination within and between units; and with adjacent forces and higher-command echelons.

Among desirable capabilities for verifying effectiveness of unit training level are the ability to simulate and evaluate:

a. Operations under degraded conditions of:
   - Environment
   - Sensor and weapons performance
   - C3I
   - Unit personnel strength

b. The degree of simulation realism in weapons effects and effectiveness.

c. Operations under various missions.

d. Sensitivity of unit effectiveness to important battlefield conditions and parameters.

Under the learning objective, TES should be able to provide sufficient instrumentation and flexibility for the evaluation and exploration of:

a. The exploitation of unexpected vulnerabilities or tactical errors of opposing forces.

b. The effectiveness of measures to increase survivability, including both reducing detectibility and increasing physical protection.

c. Payoffs from major product-improvements of weapons, combat support, combat service support and the introduction of new weapons systems, tactics and techniques.

d. Alternate scenarios under various conditions of terrain and weather.

e. The performance of commanders at relevant levels.

f. The effectiveness of the simulation surrogates for weapons and sensors of all branches and Services involved.

The totality of these TES requirements represent a tall order, if not an impossible dream. Overall, the modern battlefield is so complex that only a few of the more critical linkages can be played as real-time variables. Certain of the most important other linkages can, however, be represented in the input data or rules of engagement.

The most important constraints on present military training, which Tactical Engagement Simulation might strive to mitigate, are listed in Table 2.

Table 2. PRINCIPAL TRAINING CONSTRAINTS

| | | |
|---|---|---|
| Geographic | - | Confined area, few terrain options. |
| Environmental | - | Minimal obscuration (e.g., smoke), NBC, electronic emissions. |
| Cost/availability | - | Conservation of sensors, weapons, expendables. |
| Realism, stress | - | Safety first, minimal risk, hazard. |
| Inter-operability representation | - | Little IFF, close air support. |
| Remote weapon and sensor effects | - | Insufficient area for stand-off of long-range sensors and weapons. |
| Safety | - | Live fire, explosives, vehicle movements, night operations. |
| Time between scheduled exercises | - | Restricts play for time and labor-intensive elements, (e.g. mines). |

## 6. TOWARDS GREATER FIDELITY AND REALISM IN SIMULATION

The limitations of simulation are well illustrated by the use of a triggered laser aiming device mounted coaxially on a rifle as a substitute for actual firing in preliminary marksmanship training. An actual firing of a rifle involves not only careful sighting, slow trigger pull, evaluation of the target miss distance, and several strongly-enforced range-safety rules, but also numerous distracting and possibly stressful cues: a loud bang and consequent tinnitis, muzzle blast, recoil and accompanying shoulder impact, uncontrollable climb in muzzle elevation (particularly in automatic fire), and the acrid smell, taste and lachrymator effect of the incompletely burned propellant gases.

When the simulation system does not include these effects much of its value may be compromised, for it is these effects that are mainly responsible for a nonsteady trigger pull, flinching and blinking at the critical moment.

The simulation could be made more realistic by incorporating the firing of blanks as is done with MILES, but blank ammunition is a major factor in the cost of training exercises. A spring-loaded or magnetic device in the training rifle stock, actuated by the trigger to deliver a healthy kick to the trainee's shoulder simultaneous with the laser firing, might be an alternative to the use of blanks. Simulation of elevation required by trajectory drop and of windage corrections can presumably be inserted artificially by offset of the laser-muzzle alignment; leading a moving target in real-time to allow for bullet flight time and target "crawlage" can be simulated to some extent by delay of the laser pulse. Which of these additional cues would improve the exercise must be more closely evaluated.

In moving from individual proficiency training to crew and unit training, several critical new elements are introduced--particularly cooperation, timing, peer pressures and additional safety requirements. These become more complex and more critical as unit size increases.

The MILES system relies on the symbolism of a buzzer or tone to indicate a target (sensor) hit or a near-miss. Similar limitations of the SAWE-IFS system include lack of:

a. A launcher muzzle-blast signature, which may have an important psychological effect for those cases where sound precedes the projectile arrival. What self-protective measures should be taken when thus warned of being fired upon?

b. Realistic (nonsymbolic) effects, such as: the sounds of high-speed fragments; strong shock waves, as from nearby shell explosions; simulated shouts and screams of the wounded; etc.

c. Direct unpleasant effects on exposed personnel.

Further, there is an opportunity to enhance the realism of weapons effects at the MILES targets by providing through earphones various acoustic effects that simulate, for example, the crack of rifle fire, the shock wave of a near-miss bullet, etc. Such sound effects can make an important contribution in simulating some of the frightening distractions of the battlefield, and in inducing a variety of automatic self-protective responses such as ducking, taking cover, hitting the dirt, etc.

The normal "antenna pattern" of the human ears, together with the brain's marvelous computer/analyzer permits determining the azimuth of an isolated sound source often within about 5 degrees. This capability can be exploited by providing various stereo acoustic stimuli* to the trainee through earphones.

The importance of motivation and stress in simulation is addressed in some detail in Annex D.

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* During the Vietnam War, the LTV Corporation developed a prototype stereo acoustic sensor designed to pick up the sounds of enemy troop movement, for example, along jungle trails. Recording of field trials of a squad walking by gave a high-fidelity acoustic "image" of their approach from the left and recession toward the right. Quite incidentally, the sound of a bee buzzing the sensor came though in such realistic stereo that every listener automatically ducked or took other evasive action to avoid the bee.

## 7. SOME NEW TES CONCEPTS

Beyond possible enhancements of the realism and fidelity of the existing MILES and SAWE training systems is the question of exploiting simulation for other major battlefield systems and environments.

According to the summary cited earlier, two of these are currently in development planning, but with tentative deployment dates several years hence:

a. The SAWE Mine Effects Simulation Devices (SAWE-MES) described above; and

b. The SAWE Nuclear, Biological and Chemical (SAWE-NBC) simulation devices.

To be of greatest use to the Army, TES development projects should address those equipments and situations that are:

a. Indigenous to the battlefield.

b. Highly proliferated.

c. Likely to be employed by possible adversaries.

d. Highly effective.

e. Which, without simulation, would require repetitive and costly use of expendables.

In scoring training in the use of such direct fire weapons as the ubiquitous rifle and machine gun, MILES clearly satisfies these criteria. However, there are other important weapons systems used in direct fire modes that also satisfy these criteria but to which MILES has not yet been adapted:

a. The hand grenade.

b. The shoulder-fired M79 grenade launcher.

c. Shoulder-fired anti-tank weapons (e.g., M72 LAW).

d. Recoil-less rifles (60mm, 106mm).

e. Mortars (81mm, 4.2-inch).

All of these, of course, have counterparts in the arsenals of potential US adversaries. We are told that lack of specific requirements and funds has so far precluded the development of simulators for these weapons.

The following paragraphs describe some proposed extensions of existing simulation systems and methods, together with some larger candidates and concepts for simulation that emerged in the Workshop discussions.

## 7.1 Grenade Simulation

The SAWE Player Detector Device (PDD) is designed to be triggered by the acoustic signal (a whistling sound) generated aerodynamically by the incoming SAWE-IFS round. The changing closing speed of the falling round causes a changing Doppler frequency shift (an acoustic signature that would be difficult to mimic by a grenade simulator lying on the ground).

However, the SAWE PDD can also be triggered by a pair of fixed acoustic frequency signals, as is used for simulation of land mines. Using this technique, it should be a straightforward matter to develop a simulated hand grenade to activate the SAWE acoustic receiver. The same fuzing mechanism as in a real hand grenade could be used, only instead of setting off a large charge, it would (after its normal time delay) ignite a pyrotechnic whistle designed to produce the range of frequencies that would trigger the SAWE PDD.

For reasons of safety it has to be recognized that even a thrown rock can cause injury. To avoid this hazard the grenade case could be made undersized and provided with a rubber or styrofoam coating. Properly designed, the weight and drag could be kept similar to the real hand grenade, so it would throw like the real thing, a definite requirement. The rubber or styrofoam coating could have enough yield to prevent serious injury.

## 7.2 MILES in Obscurants

For certain regimes of aerosol densities, FLIR imaging sights (e.g., on tanks or helicopters) can see targets in fog or smoke that is effectively impenetrable to the MILES laser beam, which thus inadequately simulates the target engagement environment. Two approaches toward removing this limitation are suggested:

a. Use of more penetrating laser frequencies or adaptation of millimeter wave technology.

b. Use on the target vehicle of a narrow-band IR omnidirectional emitter; and on the firing unit, a narrow field-of-view IR sensor whose triggered receiver-gate opening simulates firing.

These approaches are described in more detail in Annex B.

## 7.3 Exploitation of Digital Data Links

Digital data links (DDL) and digital computers are becoming increasingly common components of military systems. By the mid-1990's almost all significant items of mobile Army equipment will have DDL and computer capabilities on board. Those key equipments lacking these capabilities can be augmented with strap-on systems. These operational resources can be exploited for training purposes.

Data links can be used to transfer information such as identity, status, activity and weapons effects between the Tactical Training Integrated Control System (TACTICS) and the individual players. The on-board computers can be used to monitor the equipment status and activity, and to transfer the information via DDL to TACTICS as well as being used to produce effects called for by information received from TACTICS. Additionally, the same processors can be used for embedded, stand-alone crew training purposes.

DDL, on-board computers, and TACTICS, coupled with a system for accurately locating player elements, will provide a foundation for shifting the burden of realistic tactical simulation, including engagement resolution and effects, from hardware to software. Hardware simulation will be required only when it is necessary to produce cues for the physical senses (e.g., visible, audible) that must be perceived directly by the individual soldiers. These cue simulators would be controlled by TACTICS and produce cues in a coordinated fashion with the software-simulated agent, events and effects information.

A current example of the use of DDL is the Mobile Automated Field Instrumentation System (MAFIS) under development by TRADOC, as discussed in Section 2.

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Data links can be used to transfer information such as identity, status, activity and weapons effects between the Tactical Training Integrated Control System (TACTICS) and the individual players. The on-board computers can be used to monitor the equipment status and activity, and to transfer the information via DDL to TACTICS as well as being used to produce effects called for by information received from TACTICS. Additionally, the same processors can be used for embedded, stand-alone crew training purposes.

DDL, on-board computers, and TACTICS, coupled with a system for accurately locating player elements, will provide a foundation for shifting the burden of realistic tactical simulation, including engagement resolution and effects, from hardware to software. Hardware simulation will be required only when it is necessary to produce cues for the physical senses (e.g., visible, audible) that must be perceived directly by the individual soldiers. These cue simulators would be controlled by TACTICS and produce cues in a coordinated fashion with the software-simulated agent, events and effects information.

A current example of the use of DDL is the Mobile Automated Field Instrumentation System (MAFIS) under development by TRADOC, as discussed in Section 2.

## 7.4 Software in Simulation

The use of an open-architecture computer-control system with two-way linkages between elements in the training area can not only make fuller use of the physical effects of hardware simulators but also, through software processing, extend the simulation geographically and functionally and even substitute in some degree for hardware simulators. These concepts are discussed more fully in Annex C.

## 7.5 Scaling

One of the principal constraints in conducting Tactical Engagement Simulations is the limited land area available for local maneuver and field operations, as well as the extent of the contiguous area for positioning of remote sensors, jammers, weapons, etc., whose operation can strongly influence, or perhaps even dominate, the local battle. A related constraint is the ability to operate sensors and jammers at full power.

It is suggested that, for at least a fraction of the field exercises, the principle of scaling could be applied tc sensors (e.g., radars), weapons and communications to simulate operations in an area of perhaps 100 times that available.

The Scaling concept, together with several proposed technical approaches, is described in some detail in Annex E, and summarized in Table 3.

Table 3. SUMMARY OF SIMULATION SCALING CONCEPT AND APPROACHES

| | |
|---|---|
| CONCEPT | - Simulate expanded-area operations (through "scaling") to overcome constraints of areas available. |
| APPROACH | - Scale ranges of organic sensors and weapons. |
| | - Overlay with sensors and jammers located around actual training-area periphery so as to give true elevation angles and line-of-sight. |
| | - Scale unit, vehicle and personnel spacings and speeds of movement. |
| | - Provide both Blue and Red forces with appropriate degrees of control over supporting external weapons and sensors. |
| | - Operate radiating sensors, simulated target returns, and other EW gear at reduced powers (e.g., scaled appropriately as 1/R2, 1/R4). |
| | - Integrate instrumentation with tactical sensor and jamming overlay nets. |
| | - Utilize tethered balloons as necessary to achieve higher elevation angles and greater area coverage. |
| ADVANTAGES | - Allow exercise of larger-size forces in restricted areas available. |
| | - Demonstrate payoff of Detection/Avoidance measures. |
| | - Allow realistic jamming at tolerable power levels (confined to training area). |
| | - Require only readily attainable antenna-mast heights because of short ranges. |

## 7.6 Simulation of Gunnery

Although simulation has long been used by the Army in training individuals in tank gunnery, the inclusion of gunnery simulation in tactical engagement training is only now beginning to be addressed. An RFP has just been issued for the Tank Weapons Gunnery Simulation System (TWGSS, cf. Section 2 and Annex F) for the M1, M1A1 and M60A3 tanks, and a companion Precision Gunnery System (PGS) for the M2/3 vehicles. This is indicative of the seriousness of the Army's intention to incorporate gunnery simulation in tactical exercises. Many of the issues involving the interaction of TWGSS with MILES (and SAWE) evidently remain to be solved. These represent further opportunities for fruitful application of technology to TES. The requirements of the RFP, and particularly the implications for the interaction with MILES, are discussed in some detail in Annex E.

## 7.7 Joint Air/Ground Operations

The Army's training program has followed a logical development from the training of individuals through crews and units to the current large-scale tactical engagement training. The next step is evidently the inclusion of air assets. Although the Army already incorporates its helicopters in training exercises with ground forces, involving tactical fixed-wing forces requires establishment of joint Army/Air Force training exercises. A proposed program for joint air/ground training operations making extensive use of simulation is described in some detail in Annex G, and summarized in Table 4.

Table 4. JOINT AIR/GROUND OPERATIONS

Focus on Battalion Task Force and Brigade
- Simulations of higher echelons
- Training of Key Players, Pilots, Commanders and Staffs

Environments
- Red Air/Blue Air Defense
- Blue Air/Red Air Defense

The Need
- Practice Area for Service Interface
  - Target designation and hand-off (Scout, Cobra, fighter, artillery)
  - Coordination of air space over units
  - Artillery coordination with fighters and helicopters
- Training Implications for Specialized Light Force Units
  - Air assault--high density of air assets
  - Airborne--traditional Joint Exercises
  - Ranger--planning and C3I
- Evolution of AGES/Air Defense
- Emergence of centralized ranges
- Formation of Army Aviation Branch

Joint Approaches
- Air Force--Definition of USAF CAS Needs, EW simulation expertise
- Army--CAS Needs, Provide contract mechanics, AGES/AD expertise
- Funding

Recommendations
- Systems approach to Air/Ground Engagement Simulation (USAF/USA)
- Hardware/Software (for central ranges)
  - Aircraft vulnerability played
  - Electromagnetic range matrix
  - Range position location system (casual assessments combined)
  - TES Pods for A-10, F14/15, etc.
  - Mobile radar simulators developed--acquisition/guidance
- Organizational
  - USAF (maybe USMC also) SAG member for JPL TES initiative
  - Joint 4-star briefings on progress on hardware/software

## 8. RELATION TO THE ACTUAL BATTLEFIELD

In focusing on the needs and deficiencies in training it is sometimes difficult to distinguish training needs from similar needs and deficiencies encountered in actual battlefield environment, tactics, and equipment. But the two types of deficiencies are intimately related, and have many aspects in common. Thus, for example, in monitoring, scoring and extracting lessons from large-scale tactical engagement exercises, it would be very useful to know the precise location of all battlefield elements at all times. This calls for a Position-Location Reporting System (PLRS), which our field forces have also asked for, but which has not yet been fully developed or deployed.

In projecting training simulation requirements it is necessary to consider the length of the development cycle time. Considering the many approval steps and funding hurdles, a full decade may be required for procurement and widespread deployment of a major system. It is thus essential to foresee the major trends, in equipment, tactics, theaters, and warfare scenarios, to ensure that when the simulation systems finally become available, they will support training that is timely, relevant and effective.

Examples particularly relevant to the European Theater of Operations (ETO) include joint air-ground operations and defense against sabotage and "fifth-column" operations. If the Army continues its focus on the Central European theater, perhaps the most glaring void (or, more positively, the most outstanding opportunity) in simulation for training lies in combined-arms or joint operations such as air-ground attack and its counterparts, air defense and the suppression of air defenses, and general base defense. Without an official vote, it was the consensus of the conferees at this Workshop that joint air-ground/ground-air operations as elements of tactical engagement are next in priority for training simulation of the classical European battlefield in modern form. An immediate need would then be the simulation of air-delivered ordnance. This might be met by an adaptation of the SAWE-IFS technology, as described in Section 5.

## 9. SOME CANDIDATE RECOMMENDATIONS

The very limited time available for discussion during the Workshop precluded developing any group consensus on a list of recommendations or prioritizing them and estimating target dates for their technical achievability. With this caveat, the most that can be offered is a summary of the various candidate recommendations that have been suggested by the various Workshop Panel members. Wherever possible, these are accompanied by references to the text and/or annexes in which they are discussed.

It should be emphasized that many of these candidate recommendations might well have been approved by the whole panel, but there was no opportunity for the full discussion needed to arrive at such a consensus. The panel members are fully aware of the fragmented and unintegrated menu of tentative recommendations that follows.

### 9.1 General

a. The focus of TES should be on maneuvering-size units and middle-echelons, i.e., not larger than brigade.

b. A total systems approach should be considered for TES, including: joint and combined arms, especially air-ground; heavy/light; and high-, mid- and low-intensity.

c. Major trends in technology that will impact the feasibility and affordability of potential TES developments should be considered:

1. More powerful, smaller computers, at lower costs.
2. Smaller sophisticated communications devices.
3. Piecemeal development of training devices for individual weapons.
4. Increasing costs of actual munitions.
5. Increasing costs of weapons systems, making the experience of operators crucial.

### 9.2 Specific

a. Extension of tactical-engagement training, and corresponding simulation, to include particularly combined-arms air-ground and ground-air exercises jointly with USAF and/or USMC fixed-wing tactical aircraft. The simulation of certain aspects of such joint exercises is addressed in the Army's AGES program (Sections 2, 7.7; Annex G).

b. Simulation of air-delivered ordnance, possibly based on the SAWE-IFS technology (Section 5).

c. Simulation of gunnery via TWGSS and PGS (Section 7.6; Annex F).

d. Exploitation of software where possible as a substitute for hardware to provide cues and other simulated effects (Section 7.4; Annex C).

e. Exploitation of digital data links to provide both genuine and simulated information, cues, etc. (Section 7.3; Annex C).

f. Utilization of scaling to extend the effective area and resources of the training ranges (Section 7.5; Annex D).

g. Adaptation of the MILES-SAWE technologies to the simulation of other highly-proliferated weapons systems such as: mines; antitank missiles; grenades, both hand- and launcher-projected; etc. (Sections 2 and 7.1).

h. Simulation of jamming and other electronic warfare measures, electronic countermeasures (ECM) and counter-counter measures (ECCM) (Section 5).

i. Simulation of battlefield sounds through acoustic generators to enhance realism via stereo-acoustic stimuli to the trainee through earphones (Section 6).

j. Encouragement and support of technologies having promise of important application to tactical engagement simulation.

# APPENDIX A

## CHARTER: WORKSHOP OBJECTIVES

JPL has been tasked by the US Army Project Manager Training Devices (PM TRADE) to provide the Army with a report that describes the technology development programs that will be needed to support future generation Tactical Engagement Simulation (TES) systems. These future TES systems will be used in Army force-on-force training exercises in the years 1995-2000 and beyond.

The overall objective of this Workshop is to provide the SAWE team at JPL some new ideas and guidance for the development of the next generation of Tactical Engagement Simulation (TES) systems for Army force-on-force training.

Specifically, this will involve:

1. Suggesting technological approaches that might be used to solve specific TES issues presented by JPL.

2. Identifying those current technologies that are not yet mature but that should be supported by the Army to ensure success of future generation TES.

APPENDIX B

WORKSHOP PANEL MEMBERS AND ATTENDEES

21-22 April 1987

Panel Members

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Other Attendees

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Mr. Joe Thompson

Army Training Support Center

Mr. Chuck Tallman

JPL

Mr. Jack Battenburg
Prof. Robert Beaudet
Mr. Joe Bruman
Mr. Warren Dowler
Mr. Ned Ferraro
Mr. Dan Griffin
Mr. Jon Inskeep
Mr. Gordon Wilker

## APPENDIX C

FUTURE GENERATION
TACTICAL ENGAGEMENT SIMULATION SYSTEMS WORKSHOP

AGENDA

Caltech Alumni House
345 S. Hill Street
Pasadena, California

**Tuesday, 21 April 1987**

| | |
|---|---|
| 8:30 am | Welcome (Bob Beaudet) |
| 8:40 am | Overview of the SAWE Project (Jack Battenburg) |
| 9:00 am | Comments on Training (Dan Griffin) |
| 9:15 am | Tactical Engagement Simulation: The Issues for Future Generation Systems (Jon Inskeep) |
| 9:55 am | Ground Rules for the Workshop (Bob Beaudet) |
| 10:00 am | Panel Discussions (Bill McMillan, Moderator) |
| 12:00 pm | Lunch (Caltech Athenaeum) |
| 1:00 pm | Panel Discussions |
| 5:30 pm | Adjournment to Dinner |
| 6:00 pm | Dinner |

**Wednesday, 22 April 1987**

| | |
|---|---|
| 8:30 am | Continue Panel Discussions |
| 11:30 am | Writing Assignments |
| 12:00 pm | Lunch (Caltech Athenaeum) |
| 1:00 pm | Writing Session |
| 3:00 pm | Reading and Editing |
| 4:30 pm | Closing Summary (Bill McMillan) |
| 5:00 pm | Adjournment |

Department of The Army
Headquarters, United States Army Forces Command
Fort McPherson, Georgia 30330-6000
1 January 1987

*FORSCOM Pamphlet 350-15

## Training

# FIVE YEAR TRAINING DEVICES PLAN, FY 87-91

**APPLICABILITY.** This publication is intended for the use of commanders, trainers, and training support personnel at separate brigade and higher level. Specific agencies include: Corps, Active and Reserve Component Divisions and Separate Brigades, CONUSA, Readiness Groups, ARCOM, COSCOM, and Adjutants General.

**SUMMARY.** The FORSCOM Five Year Training Device Plan FY 87-91 (FYTDP 87-91) is a reference publication for planning purposes that identifies and addresses the distribution of training devices and simulations scheduled to be fielded during FY 87-91. This publication is a "living document" that can assist you in the identification of training device and simulation requirements. It further provides a basis for determining facility and personnel requirements for projected fielding of future training devices and, or simulations. The material in this pamphlet is not directive in nature, but is for information purposes only.

**SUGGESTED IMPROVEMENTS.** The proponent for this pamphlet is the Training Support Division, DCSOPS, HQ FORSCOM. Send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications) to: Commander, US Army Forces Command, DCSOPS, ATTN: AFOP-TS, Fort McPherson, GA 30330-6000.

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## APPENDIX E

## GLOSSARY

| | |
|---|---|
| AD | Air Defense |
| AGES | Air-Ground Engagement System |
| AWESS | Automatic Weapons Effects Signature Simulator |
| BFV | Bradley Fighting Vehicle |
| CAS | Close Air Support |
| C3I | Command, Control, Communications & Intelligence |
| DDL | Digital Data Link |
| ETO | European Theater of Operations |
| ESSLR | Eye-Safe System Laser Rangefinder |
| EW | Electronic Warfare |
| FLIR | Forward-looking Infrared |
| FORSCOM | US Army Forces Command |
| HGSS | HELLFIRE Ground Support System |
| IFF | Identification, Friend or Foe |
| IR | Infrared |
| JPL | Jet Propulsion Laboratory |
| LTID | Laser Target Interface Device |
| LWIR | Long Wavelength Infra Red |
| MAFIS | Mobile Automated Field Instrumentation System |
| MES | Mine Effects Simulator |
| MILES | Multiple Integrated Laser Engagement System |
| MOS | Military Operations Specialty |
| NBC | Nuclear, Biological & Chemical |
| PDD | Player Detector Device |

| | |
|---|---|
| PLRS | Position-Location Reporting System |
| PM-TRADE | Program Manager, Training Devices (US Army) |
| RFP | Request for Proposal |
| RPG | Rocket-Propelled Grenade |
| SAG | Scientific Advisory Group |
| SAWE | Simulation of Area Weapons Effects |
| SAWE-IFS | Simulation of Area Weapons Effects--Indirect Fire Simulation |
| SAWE-MES | Simulation of Area Special Effects--Mine Effects Simulator |
| TES | Tactical Engagement System |
| TSC | Tactical Support Center |
| TRADOC | US Army Training & Doctrine Command |
| TWGSS | Tank Weapons Gunnery Simulation System |
| UFE | Universal Field Element |

ANNEX A

NEW TECHNOLOGIES FOR TES APPLICATION
Anthony H. Francis

## A.1 Introduction

Our objective in this section is to identify technologies that will be needed to support future generations of Tactical Engagement Simulation (TES) systems. An attempt is made to identify current technologies that address specific TES problems identified by JPL and to distinguish developing technologies that should be supported because of likely future importance to TES.

For the purposes of analysis, it is convenient to divide a broad area of related technologies into sub-categories, each with a salient, defining characteristic. Such divisions are usually not unique, exclusive or of general use, but do serve the immediate goal of ordering a logical analysis. A natural division for the technologies used in TES is into the categories of METHODS, MATERIALS AND 'MECHANISMS'.

Methods suggests techniques of computing, data processing, signal generation/recovery or materials processing, that have special relevance to simulation.

Materials includes novel materials with applications to remote sensing, electronic devices, optics, acoustics, etc., all of which may find application in simulations.

'Mechanisms' refers to new applications for emerging or existing instrumentation or equipment.

We shall briefly explore each of these categories in an attempt to identify technology with potential applications in simulation, its approximate development period, and the present and likely future costs. The strategy employed is to develop a matrix of applications/technologies based, in part, on the data below, and to cross-correlate with present state-of-the-art assessments using appropriate technical references. Table A1 summarizes some of the more promising technologies and their possible applications in TES.

Table A1: SOME PROMISING TECHNOLOGIES AND POSSIBLE TES APPLICATIONS

| METHODS | APPLICATIONS |
|---|---|
| Mathematical methods for Data Processing | |
| Data base management architecture | Simulation management |
| New algorithms for weapons simulation | New weapons effects; smart weapons |
| Pattern recognition techniques | Interpretation of weapons effects; lead, direction and time of flight |
| Fractal analysis techniques | Interpretation of weapons effects; grouping and pattern interpretation |
| Micro-fabrication and machining | Microsensors for TES; weapons effects |
| TES distributed architecture | Flexible force-on-force fully implemented simulations |
| Acoustic ranging | Ranging using new materials; PST and fiber sensors |

TABLE A.1 SOME PROMISING TECHNOLOGIES AND POSSIBLE TES APPLICATIONS (Continued)

| | |
|---|---|
| **MATERIALS** | |
| MBE/CVD mm-wave oscillators | Fire direction through smoke |
| MBE/CVD photo-diode structures | MILES improvement; additional effects simulations |
| MBE/CVD laser devices | MILES improvement; additional effects simulations |
| Light `harvesting' polymers | MILES improvement; additional effects simulations |
| PZT composites and polymers | SAWE improvement |
| SAW devices | Chemical effects simulation |
| Quantum well radiators | Replacement laser materials; improved effects |
| Fiber Optics | MILES improvement; distributed sensing; multiparameter sensing |
| Photoconductive polymers | Additional effects simulations |
| HT superconductors (Josephson junction PDs) | |
| **MECHANISMS** | |
| MAFIS | |
| Laser range finding | |
| Integrated sensors | |
| Fiber optic sensors | |
| Chemically sensitive electronic devices | |
| 1-10 micron solid state lasers | |
| Integrated Optics | |
| LORAN, GPL | |

A.2 Materials

MBE and CVD materials are new semiconducting materials having a two- dimensional, layered structure, that can be prepared by Molecular Beam Epitaxy (MBE) or Chemical Vapor Deposition (CVD). These materials can be micro-engineered to have special electronic energy band-gap properties and unusual electrical characteristics which may make them extraordinarily useful in a new generation of IR detection devices. Such devices offer higher sensitivity and lower noise than conventional diode IR detectors. The lower noise characteristics may permit operation of the detectors at ambient temperatures with detectivities comparable to those presently available only with cooled detectors. In addition to savings in cost, weight and complexity, improvements in detectors used for IR ranging, sighting and weapons-effect simulation will allow reduction in the irradiance levels required for these functions. This reduction results directly in less interference between different simulation systems and in improved eye safety. A Geiger mode avalanche photodiode has already been employed for very high precision laser ranging at very low light levels, and an experimental evaluation of the technology for this application has been given by Hallsmith (1986).

Perhaps of greater importance, however, is the possibility for new pointing, ranging and weapons-simulation techniques that this new technology may suggest. Schemes not now practical could potentially be employed to simulate 'leading' of moving targets, and the incorporation of coding for the finite ranges of weapons. For example, more sensitive, faster detectors could permit angular sweep modulation of fire-simulation lasers to allow range information to be encoded. The potential to fabricate lasers with narrow output wavelength bands over a wide range of wavelengths would permit accurate wavelength identity coding of individual weapons.

The ability to control the gradation in composition of compound semiconductor structures by MBE has profound implications for the fabrication of novel devices from artificially-structured materials. Such structures include graded and superlattice avalanche photodetectors and lasers. The modification of bulk properties through band-gap engineering is a major development in solid-state electronics and photonics which will dramatically affect the fields of photodetectors and lasers. It is already possible to construct avalanche photodiodes with statistical noise several orders of magnitude lower than that attainable in conventional avalanche diodes. The "staircase" avalanche photodiode, constructed by MBE methods, is expected to provide a true solid-state equivalent of the photomultiplier operating in the 1-10 micron range.

Another example of the possibilities provided by band-gap engineering to fabricate novel devices is in the area of semiconductor lasers. The two most promising structures are the graded-index waveguide (in which propagating light and injected carriers are confined to different layers) and lasers with multiple quantum-well active layers. These structures provide improved noise characteristics, lower divergence, higher output powers and a wide range of operating wavelengths depending upon fabrication dimensions.

The unique capabilities of MBE and its important contributions to the field of optoelectronics are illustrated by a new generation of device structures (including quantum-well heterostructures, double-barrier double-heterostructure lasers, and graded-index separate confinement-heterostructure lasers) and by graded-band-gap avalanche photodiodes (APD) and phototransistors, superlattice APD and modulated-barrier photodiodes. These new devices, made possible by MBE, have characteristics unachieved in conventional devices (Tsang, 1984).

Some of the characteristics of MBE lasing materials include emission wavelengths of 5-6 microns at 10 mw (Parton, 1984); side-mode suppression ratios of greater than 200:1 (Hong, 1984); external quantum efficiencies of 80%; and stable, single-lobed far-field patterns with a beam divergence as narrow as 0.8 degree for a 100-micron laser (Larsson, 1986).

MBE photodiode devices have been constructed with dark current of 80 pA, a uniform quantum efficiency over the photosensitive area and linear amplification of x19 with an integrated monolithic FET (Wada, 1983). The band edge discontinuities of heterojunction APDs make the devices potentially faster than similar abrupt structures. Fast response with a full-width at half-maximum of 250 ps and no tail have been demonstrated (Capasso, 1983), as well as low dark-current combined with large photocurrent multiplication characteristics (Susa, 1984). High-speed response up to 10 GHz with gain feedback and an avalanche gain of about 60 with 4 nA dark current have been achieved in an MBE-fabricated device (Capasso, 1984).

Charge-Coupled Devices (CCDs) have developed rapidly for astrophysical applications in weak-source irradiance measurements. These devices can be coupled to a wide range of radiation detectors, including IR diodes and visible/ultraviolet detector elements. This technology is being rapidly introduced into a wide variety of instrumentation (Eden, 1982; Kosonocky, 1980). The CCD is essentially an accumulated-charge detector which gains its sensitivity by accumulating charge through a radiation-controlled gate and then counting the accumulated charge digitally. Relative levels of intensity are gauged with great accuracy. Possible advantages of this technology to simulation systems would accrue from the relatively low cost/high sensitivity of CCD optical-

detection systems. Addtionally, the devices are compact, light-weight, require only low-power and possess full three-dimensional imaging capability. Applications have been reviewed by Bredthauer (1985) and by Korneffel (1984). Recent developments of importance are in the areas of time-resolved photometry using CCDs (Howell, 1986) and the coupling of CCD process technology to MOS (CMOS) technology to provide high data-rate signal processing and extremely low operating powers.

High-Temperature Superconductors: The new high-temperature superconducting materials will ultimately provide room-temperature access to processes once attainable only at liquid-helium temperatures. Although the possibilities are manifold, several come to mind that have implications for TES. For example, a Josephson junction photo-diode operating at room temperature should revolutionize light measurement techniques. SQUID magnetometers will become commonplace disposable instrumentation.

## A.3 Methods

Micro-machining by chemical or ion-beam methods permits the integration of transducers directly on silicon wafers. At present, micro-etched silicon inclinometers, pressure transducers (microphones), accelerometers, and temperature-sensitive components have been integrated with silicon-based micro-circuitry for amplification, filtering and data-transmission (Wise and Clark, 1985). Integrated sensors and interface electronics have been reviewed by Wise (1986). In the near future, it is likely that additional micro-machining capabilities will permit more transducer functions to be carried on-board a micro-chip. This technology is potentially very important for simulation since it permits sensing a wider range of inputs for TES with lower power, lighter weight, lower cost, and more reliable equipment. In addition to sound cues, integrated sensors could determine a player's protective posture (standing, prone, MOPP heat stress, etc.) and his relative motion. This information could be used to weight statistically various weapons effects. Of course, additional data to be processed places an increased burden on the TES computer system architecture.

Optical Fiber Materials Fiber optics and optical guides (sheet and strip materials) have been dramatically improved by the communications and the solar-energy-conversion industries. Improvements in both manufacturing techniques and materials have resulted in high "gain" optical antennas and less lossy optical transmission. Further improvement in these materials can be anticipated. This technology would allow low-cost proliferation of optical sensor systems. Multi-furcated fibers are currently employed to feed multiple (individually coded) inputs to a single sensor element in an array detector.

Optical fiber sensors can be categorized according to the way in which the light is modulated: amplitude, frequency, phase and polarization modulation are possible. Optical effects are found for various types of physical stress: mechanical, electrical, magnetic, thermal, radiation and chemical stresses all interact with the fiber to produce changes in the absorption or transmission of light. An advantage of using an optical fiber is high sensitivity (particularly for phase modulation, such as in the gyroscope or acoustic-wave detector environments). Transducer types can be labeled as intrinsic (in which the fiber itself acts as transducer) or extrinsic (in which the optical transducer is separate). Optical-fiber sensors can be in the form of a distributed sensor, where light is modulated along the whole length of the fiber, or a point sensor. Examples of these different types have been discussed by Yoshino (1986), and some practical applications appropriate for TES can be projected. Spectral filtering with optical fibers is projected and a large number of types of spectral-filtering sensors can be constructed (Kakin, 1985). Optical fibers for the 2-11 micron range, of particular interest for TES, have been reviewed by Parant (1984). Materials, applications and fabrication methods for IR fibers have been discussed by Bendow, et al. (1984).

Whether for mechanical, electrical or chemical sensing, a potential advantage of an optical-fiber-based system is to be found in its distributed nature. This offers an important advantage for TES. In addition to other accepted advantages in the sensing function, one obtains a knowledge of the spatial distribution of the measurand. This important attribute has been evaluated by Rogers (1986, 1987). Fiber-optic sensors offer a number of unique features which make them attractive for a variety of applications in TES. For example, a fiber-optic sensor can be immune to electromagnetic interference, is nonelectric, is compatible with fiber telemetry, can be very sensitive as well as being small in size and weight, and may be used in the development of sensor arrays. Fiber sensors have been considered for the measurement of a large number of physical parameters, ranging from temperature and pressure to rotation rate, magnetic field, species concentration and even nuclear radiation. Applications include navigation, as well as detection.

For simulations, fiber guides with plastic disk antennas could replace the present MILES belt. It may be possible to work the fiber guides directly into the fabric of the belt or other apparel. Fibers can be woven into fabric, included in surface coatings (paint), and sheet materials can be applied for large-area surface detectors (on trucks, tanks, helicopters, etc.). Doping of the plastic optical antennas with various fluorescent or absorbing materials has been used to make wavelength-selective antennas. In this fashion, an individual Player Detector Device (PDD) could be made sensitive or insensitive to different weapons illuminators.

Optical-guide materials could reduce the cost and weight burden of the detector array used in the MILES system while permitting a greater number of array elements. Increasing the number of active array elements in turn permits more meaningful simulation of weapons effects from the illumination pattern decoded.

The array detectors themselves can be integrated directly with micro-electronic chips (integrated optics) to form a single, inexpensive, package PDD with no exposed parts or wires.

## A.4 Mechanisms

Integrated optics. Integrated optics is an area of technology of potential importance for TES. Because the present MILES TES system employs infrared detectors, add-on devices have utilized an infrared output transducer to communicate with the MILES PDD. There are opportunities for construction of microsensors with optical or IR output. Integrated optics permits direct assembly of the optical input/output transducer on the silicon-based data-processing chip. For example, fabrication of an integrated, large area, planar optical-waveguide chemical vapor microsensor has been demonstrated (Giuliani et al., 1986). A highly transparent polymer served as both the light-guiding structure as well as the chemical-sensing coating element. Sensitivity was measured to $NH_3$ and PhMe vapors, which could be used to simulate chemical warfare vapor hazards. Such a device is light weight (chip-size), low power, and could easily be integrated into the MILES/SAWE system. It is one representative of a large family of micro-sensor devices.

A number of devices are being investigated at the US Naval Research Lab for their potential application as very small, inexpensive, and sensitive detectors of chemical vapors. The technologies being developed include surface acoustic wave (SAW) devices, optical waveguide spectrometers, and vapor-sensitive organic semiconductor films. The principles behind the operation of these devices, together with some experimental detection systems which use them and typical performance characteristics, have been described by Wohltjen (1983). New developments in chemical microsensors and ultraminiature chemical instrumentation have been recently reviewed by several investigators (Clark, 1986; Jones, 1986). Chemical microsensors based on surface-impedance changes in semiconductors have been discussed by Ramsey (1985).

ANNEX B

MILES IN OBSCURANTS
David L. Fried

## B.1 The Problem

Certain types of IR-imaging devices (e.g., FLIRs) can see targets through obscurants (fog, smoke, dust) whose density is such that the near infrared laser light used in MILES cannot penetrate sufficiently to trigger the photodetector. Such obscuration occurs often enough that the ability of a tank gun or TOW, missile, using a FLIR to aim at and hit an armored vehicle, cannot be adequately simulated by the MILES system. Using the FLIR, the tank or TOW gunner can acquire, track, and aim at (and, if he had a live round, could attack) an armored vehicle even with considerable obscurant present. But because of the obscurant, when the MILES laser is fired the scoring receiver on the target vehicle may not sense it and the gunner would then not be awarded the (simulated) target kill that he was "entitled to".

There appear to be at least two technical approaches to getting around this limitation. One approach is based on the use of millimeter radiation transmitted from the attacking unit to a millimeter-wave receiver on the target unit. The other approach is based on use of narrow-band, long-wavelength infrared radiation transmitted from the target vehicle to the attacking unit, coupled with a radio link from the attacking unit to the target unit.

## B.2 The Millimeter-Wave Approach

The key features of a nominal design for the millimeterapproach are as follows: The operating wavelength would be 3 mm (90 GHz). The transmitter would consist of three dipoles arranged on an equilateral triangle (of, say, 30 cm edge length), mounted on the gun or launcher tube, so that its boresight is aligned with that of the weapon. The target unit would have a number of single dipole receivers placed at various positions around the unit. The signal received by each dipole would be separately demodulated to determine when a hit is obtained. To encode the transmitted signal so that a very narrow line-of-sight direction (i.e. the weapon aiming direction) is well defined, the relative phase of the three transmitting dipoles would be sinusoidally varied at some relatively low frequency, say 10kHz. If this is suitably arranged and the target-unit receiver is on-axis, the strength of the received signal may have some 20 kHz power modulation, but there will be no 10 kHz modulation of the received power. If the receiver is slightly off-axis, there will be some 10 kHz modulation of the received power. Using pulsed radiation the depth of 10 kHz modulation can be determined and the angular miss

distance inferred. From the strength of the received signal the range can be estimated, and from the combination, the linear miss distance can be calculated.

With 3mm radiation and a 30 cm baseline provided by the dimensions of the triangular pattern of the transmitter array, the ?/d value corresponds to 10 mrad. With a 50:1 signal-to-noise power ratio (17db), the rms noise in determining the off-axis angle will be 10 mrad/50 = 0.2 mrad. This precision should be sufficient for our purposes, and should be achievable providing that ground effects do not interfere. This latter matter needs to be evaluated experimentally (work on the STARTLE program suggests that the necessary precision should be achievable). In addition, analysis is needed to determine the possibility of achieving 17 db signal-to-noise ratio at about 3km range.

To avoid confusion by the side lobes of the radiation pattern, which occur with 10 mrad spacing, it will be necessary to operate at two adjacent wavelengths. We could, for example, use 3.0mm and 3.3mm. Then a side-lobe null (i.e., an absence of 10 kHz modulation when looking at a side-lobe peak) could not occur because the two side lobes would be at least 1 mrad apart.

B.3 The LWIR Approach

The long-wavelength infrared approach would use "omni-directional" IR radiation from a beacon on the target, together with a very narrow field-of-view receiver on the firing unit. The beacon radiation would be modulated, carrying the "serial number" of the target vehicle. If the weapon is "fired" (i.e., the receiver gate opened) when the beacon signal is in the narrow field-of-view of the firing unit, the receiver demodulator will determine the target's serial number and broadcast this number to an rf receiver on the target unit. The target unit will recognize that it has been hit by the firing unit and will proceed, as MILES now does, to calculate the probability that it has been killed.

Because the beacon wavelength is in the same spectral band that the FLIR uses, it should be no more or less severely attenuated by obscurants than is the FLIR image; and if the target is detectable in the FLIR then the beacon should be detectable by the receiver (providing the beacon intensity is properly sized). The problem is how to ensure that the beacon is detectable and that the message it carries in its modulation is accurately decodable, without making the target significantly easier to detect in the FLIR. The way to accomplish this lies in two things:

1. While the FLIR detector has to measure the value of each pixel in about 100 to 300 msec (30 frames per second with 100 to 300 pixels width in the scan direction) the beacon measurement can be allowed, say, 1/3 second, with say 15

bits in the serial number, i.e., about 20 msec per bit-measurement. This represents a noise bandwidth advantage of about 100:1, allowing the beacon to be 100 to 10 times weaker than the target pixel and yet be equally measurable.

2. Narrow-band IR radiation would allow the beacon to be weak enough not to be detectable by the FLIR and yet be strong enough to be properly decoded by our MILES receiver. If the radiated spectral bandwidth were sufficiently narrow, say 0.05 micron, then the receiver could use a comparably-narrow band cold filter and would receive only about 1% of the background flux that the FLIR detector receives. Accordingly, the specific detectivity would be 10 times higher for the MILES receiver than for the FLIR. Of course, in this narrow spectral band, the beacon would have to be 100 times more intense than the ordinary blackbody radiation of the target. Such intensities are achievable from an incandescent tungsten emitter.

ANNEX C

# TOWARDS GREATER EXPLOITATION OF SOFTWARE IN SIMULATION

Robert Hennessy

## C.1 Complementarity of Software and Hardware in Simulation

To exploit fully the effects of weapons simulations such as SAWE, both the (data) information and (physical) cues provided should be used. As developed at present, the SAWE system provides the flash, bang and smoke cues to the participating soldiers, but the information originally passed by the controlling computer to the SAWE launcher for the location and altitude of the shell burst is not further used. Because of the characteristics of the SAWE rounds, a TPQ-37 radar cannot detect them, and even if it could, the actual location of the SAWE unit would be unrealistically close.

However, if the open-architecture computer-control system were implemented, with two-way linkages between elements in the training area, the SAWE firing information could be used to advantage, through software processing, to extend the simulation geographically and functionally. For example, the information that a 155 mm shell burst has occurred at location x, y and altitude z at time t could be used to generate with software a TPQ 37 radar report of location of a virtual, i.e., fictitious, artillery battery that is, say, 10 kilometers outside the actual training area. This report could then be used to direct (simulated) counterbattery fire. If the counterbattery fire is executed successfully, and this information is available to the controlling computer, the SAWE could be commanded to stop firing because the battery it represents has been put out of action.

A related advantage accruing from the open architecture control system is the use of software for simulation to obviate the need for special hardware simulation devices for every existing and new type of weapon system of concern. In the case of the preceding example, it would not be necessary to develop hardware for a TPQ 37 radar simulator to detect SAWE rounds and thus allow counterbattery fire. If it becomes desirable to simulate the effects of smart weapons and, perhaps, active countermeasures against them, new software could be written to provide the information and effects of the weapons or countermeasures, and the TES could be used to provide the cue effects that would be perceived by the soldiers.

## C.2 Simulation, Stimulation and Embedded Simulation

Producing effects for training or evaluation purposes can occur at several levels depending on how an event is sensed and the effects caused by the (real) event. If the event is to be sensed directly by soldiers (i.e., to provide visual or sound cues without the intervention of display screens, earphones or other intermediary devices), then it is usually necessary to use hardware to simulate the device causing the effect. If indirect fire is to be perceived by soldiers then a simulated artillery round, as is the case with SAWE, is the most appropriate level; but even here the SAWE does not simulate the flash or sound of the artillery tube firing. If the event is to be detected exclusively by a sensor that in turns transforms the stimulus into some other form, such as a pictorial or numeric display, then several possibilities exist:

a) simulate the agent of the event;
b) stimulate the sensor with the appropriate signal sensor;
c) inject a signal system equivalent to the output of the sensor;
d) inject signal from embedded simulation;
e) inject information equivalent to the output of the processor of the sensor information;
f) inject display information that is equivalent to the display or output of the system itself;
g) simulate the entire system.

The choice of simulation method depends on whether cues as well as information need be generated, whether real equipment is as convenient and economical to use as a special simulator, and the sophistication of the information that must be generated elsewhere. Note that if the information generation capability is embedded in the device itself, stand-alone training as well as integrated training is possible.

ANNEX D

# MOTIVATION AND STRESS IN SIMULATION

Robert Hennessy

Realistic simulation of devices and situations, properly used, can produce training more effective than even actual experience of the real events. The realism of the devices and events themselves is not necessarily the dominant factor in effective training. The way training devices are used can be much more important. Realism is an enhancing factor in a well-designed training program.

Two of the beneficial enhancements attributed to realistic simulation are the motivational and stress effects imparted to the trainees. For the most part, these effects do occur. However, the nature of the agent and effects are frequently characterized incompletely in military training. Motivation and stress do not come directly from induced fear nor from material realism. Rather, significant degrees of motivation and stress come from the demands of physical exertion, task requirements and peer pressures to perform wholeheartedly in the full milieu of the environment that includes the equipment, scenario, tasks and presence of others playing their roles in the exercise.

No equipment item in isolation produces motivation. Motivation is an attitude consequent to acceptance and involvement in the exercise, whether real or simulated. Motivation also stems from the anticipation of satisfaction in achieving a desired outcome from one's actions. It is rewarding to know and experience the consequences of doing things properly. As a corollary, the experience of failure, when stemming from a recognized wrong action also can be motivating--in the next attempt. Consequences not contingent on one's actions diminish motivation. Realistic simulation requires that the simulated environment not be arbitrary in appearance, effect or response to one's actions.

In military training where there is a hazard in the real task, it is often thought that a good, realistic simulation will have a "pucker factor," that is, produce a stressful sense of risk or even fear. No simulation that is recognized as such will ever impart any degree of fear when there is no genuine hazard. However, fear is not the only form of stress that can occur in a realistic simulation.

The flash, bang and smoke of a SAWE-IFS round provides the perceptual cues and information suggestive of a real airburst artillery shell. This simulation motivates the soldier not because it causes a fear response to the real thing, but rather because it provides the cues and information to elicit appropriate recognition and behavior, and does not provide cues suggestive of something

other than an artillery round. The simulated round is more or less consistent with reality in most respects except for the lack of danger and fear. The learning that occurs in training provides both a physical and psychological means for overcoming the fear that is inevitable in the life-threatening situation of the real battlefield.

The stresses that do occur in a comprehensive, realistic simulation are physical stress, task stress and social stress. The presence of these types of stress do promote beneficial learning. (There is such a thing as nonbeneficial learning. In the TES context, for example, this is most commonly manifested by learning to cope with the simulation rather than what is being simulated.)

The presence of physical stress during training, from fatigue, heat or cold, hunger, etc.--if it also occurs in the real situation--is a good thing because it requires learning to perform tasks under the conditions that occur in reality. This situational learning produces ways of doing things, such as moving about or manipulating equipment, that compensate or are more compatible with the stress condition than alternative ways developed in the absence of the stress. For example, a fresh soldier, unburdened with his personal field gear, might clear low obstacles--such as tree trunks--by jumping over them. But when fatigued and weighed down, he may not be able to clear the obstacle by jumping. He may learn, however, that stepping on the obstacle or doing a shoulder-roll over it conserves energy while insuring that the obstacle will be cleared safely.

A corollary to the value of situational learning is that a simulation, to be realistic, must exclude cues and information that are inconsistent with the situation being simulated. Extraneous factors can induce behavior that is inappropriate and in conflict with the training goals. Intrusions of outside reality or failures of the simulated reality can cause concentration to be broken, the tempo of activity to be disrupted and the whole exercise to recede from the realm of immediate involvement by the soldier.

Task stress accrues from the number, timing and effort of activities required to perform a continuing sequence of operations to achieve a desired goal. In realistic ground-combat simulation, prominent task-demands are to avoid being hit and to close with and engage the enemy. In simple terms, a soldier can be caught up in the demands placed on him in a simulation. That no harm will come to the soldier or his adversaries is forgotten in the press of activities ongoing in the surround and in the urgent need to respond to the task demands of the battlefield.

Social stress develops from the need to maintain self-esteem, which is manifest as a desire to perform as expected by peers and superiors. The essence of military operations is dependable team performance. The need to perform well as an individual to achieve

the team goal, and avoid the consequences of failure, e.g., criticism, retribution and acrimony, create a stressful situation that compels the soldier to attend to his assigned role. Note that the social stress is mutually reinforcing: if the general attitude of the unit is to take the simulation exercise seriously, then the attitudes and actions of each individual will both draw from and contribute support to the others.

All simulation is a corruption of reality and incomplete in some way. The choice of what should be included and left out of a realistic simulation should not be based on a desire for superficial (albeit vivid) cues, but on the ability of the simulation and its constituent factors to provide the information and produce the motivation and stress that contribute to effective and efficient learning of the individual soldier, the unit and its leader.

ANNEX E

SCALING
Richard Montgomery

## E.1 The Problem

One of the principal constraints in conducting Tactical Engagement Simulations is the limited land area available for local maneuver and field operations, as well as the extent of the contiguous area for positioning of remote sensors, jammers, weapons, etc., whose operation can strongly influence--or perhaps even dominate--the local battle. Another constraint is the ability to operate sensors and jammers at full power.

## E.2 The Scaling

It is suggested that, for at least a fraction of the field exercises, the principle of scaling be applied to sensors (e.g., radars), weapons and communications to simulate operations in an area of perhaps 100 times that available. This would permit use of very low powers in jammers and sensors. Stand-off airborne sensors with small grazing angles could be simulated from peripheral elevated antenna masts, as could also stand-off airborne jammers. Speed of movement of vehicles could be similarly scaled.

The peripheral antenna masts, perhaps supplemented by a central unit, would support the network of sensors, jammers, and monitors which could be linked with optical fibers and controlled remotely by computer. The ground-based antennas could be augmented with balloon-mounted sensors, jammers, and communications, as necessary or useful.

The advantages of such a capability would be to permit play of stand-off elements (sensors and weapons) in a more realistic nonpreplanned fashion; to allow representations of detection avoidance or confusion techniques, both technical and tactical; and to provide realistic jamming environments with very low-power emission.

E.3 Technical Approach

The largest permanent training area available to the U.S. Army is at Fort Irwin, and is only 20x30 km in extent for the instrumented portion. It would be possible to extend the area instrumented at considerable cost, but to achieve a factor of 10 in linear dimensions or 100 in area would be prohibitively costly. Other existing training areas are smaller (e.g., Ft Hood and Ft Knox).

Line-of-sight (LOS) jamming signal strength varies as 1/R2, which permits emulation of a signal from an airborne jammer at 5 km altitude, 250 km range and 50 watts/MHz (ERP) by a device at 5 km range emitting 0.02 watts/MHz from a relative antenna height of only a few meters to provide LOS at grazing angle, or of 100 meters (obtained by a combination of terrain selection and antenna elevation) to provide equivalent elevation angles.

The power required of radars and similar active sensors varies as 1/R4 for monostatic systems and closer to 1/R2 for bistatic systems. This suggests a technical comparison of the two approaches, but clearly illustrates the need for only relatively small powers to replicate the vulnerability of the force elements to detection by opposing-force sensors. Considerations for the monostatic approach would be similar for stand-off jamming. Illumination of the maneuver area from several small utility aircraft would probably suffice in the bi-static mode with a ring of elevated receivers to detect target motion.

Similarly, the allowable detection ranges, weapon ranges, and movement velocities should be scaled by a factor of 10--or nonreal time used for an equivalent scaling.

With these adjustments it may be possible to handle larger unit simulations--for example, with two brigades at NTC operating simultaneously but with reduced element spacing.

ANNEX F

COMMENTS ON TWGSS/PGS
COL Richard I. Edwards, USA (RET)

F1. SUMMARY

The US Army is currently planning to procure a laser-based gunnery trainer for the M1, M1A1, M60A3 vehicles (TWGSS) and for the M2/3 vehicles (PGS). The acronyms stand for Tank Weapons Gunnery Simulation System, and Precision Gunnery System respectively. Responses to the request for proposal (RFP) are due back to the Army no later than 23 July. Procurement is being done through the U.S. Army Project Manager, Training Device s (PM TRADE), the same office responsible for the initial MILES and AGES/AD programs. If procured with the desired capabilities stated in the RFP, these systems will provide initial gunnery systems to the MILES, AGES/AD engagement simulation environment beginning in 1989. Deliveries are planned to equip approximately three platoons in all US Army heavy battalions by 1992.

F2. SPECIFICS

a. TECHNICAL REQUIREMENT. For the tank, gunnery systems will simulate: main gun and coaxial machine gun for all ammunition and fuzes. The simulation for the Bradley will be: TOW, chain gun and coaxial machine gun. All ballistic curves for all systems, both TWGSS and PGS, are to be replicated. These systems will allow training, simulating degrading the various sight and stabilization systems on the host vehicle. The desired system considers such factors for the firing vehicle as: cant, pointing direction, acceleration, and movement. Factors considered for the target vehicle include: hull-to-turret angle and actual pierce point vulnerabilities. Long and short shot effects are also simulated. The gunner looking through his sight sees the simulated obscuration of the firing of the main gun (or missile) and the tracer track for all replicated weapons. Actual range and time of flight are to be replicated.

b. MILES COMPATABILITY. The desired system will function with the use of retro-reflectors on all player vehicles for the laser beam from the firing vehicle; any MILES-equipped vehicles will thus be required to have retro-reflectors, in addition to the normal MILES-installed equipment. The RFP requirement specifies that the MILES-equipped crew must have no additional input to the simulation, beyond what is

required by MILES. There are no current plans for the interplay of any AGES/AD vehicles/weapons in the TWGSS/PGS environment, but it is probably a growth capability under active consideration.

c. SCHEDULE. TWGSS/PGS is being procured as a Non Developmental Item with as much dispatch as can be mustered. Sufficient systems are to be delivered for First Article Test within 6 months of award of contract (tentatively Jan/Feb 88). The first unit deliveries, required for 19 months after award of contract, include 84 M1, 98 M1A1, 28 M60A3 TWGSS Systems, and 52 M2/3 PGS Systems. Other additional systems are to be delivered in subsequent lots, depending on the execution of various options by the Army.

F3. ASSESSMENT

a. GUNNERY AND ENGAGEMENT SIMULATION. It would appear that the Army is fully committed to the application of some type of gunnery training device for the training of units at home station. The degree of commitment will probably depend on ultimate cost of the devices, which will potentially be higher than the current MILE. The insistence on the interoperability of TWGSS/PGS with MILES and AGES/AD suggests that, although the former units are intended primarily as gunnery trainers, they represent a splendid opportunity to improve the realism of engagement simulation training. If cost should prove a problem, then TWGSS/PGS will remain relegated to the role of a gunnery trainer at home station only.

b. TWGSS/PGS A FIRST GENERATION SYSTEM. There may be some substantial problems in making TWGSS/PGS interoperable with MILES. Some of the original algorithms embedded in the MILES system do not lend themselves well to true gunnery solutions. Moreover, TWGSS/PGS specifications do not address the world of dismounted players. Time will reveal how successful the winner of the TWGSS/PGS Contract will be in designing a system that is potentially broader than supporting a mounted heavy force engagement simulation only.

c. SECOND GENERATION SOLUTIONS. There is little likelihood that the TWGSS/PGS system will meet all the issues posed to the TES Workshop panel for possible solutions to engagement simulation problems of the future. When fielded, TWGSS/PGS will offer some insights into what may be achievable with a laser-only based system. It will not offer any help in the solution of the huge problem of battlefield obscuration, and the inability to simulate accurate firing with the thermal sight through such obscuration. It therefore seems

reasonable to assume that TWGSS/PGS, like MILES, represents a first generation system only, and that a broadened engagement simulation-instrumentation system of the year 2000 and beyond will consider both MILES-AGES/AD and TWGSS/PGS. Many of the elements for support of a combined instrumentation system are within the TWGSS/PGS system. (There are sensors on the host vehicle which accurately determine the pointing angles, the turret-to-hull angles, and vehicle acceleration and speed.) What is still not available is some type of digital intercommunication system, and a distributed awareness for players of the status of the unit in training. MAFIS, as a first generation system, offers some of the missing answers. The combination of MAFIS and TWGSS/PGS, and a broad technical search for any other missing technologies, should form the basis for exploiting state-of-the-art in rapid movement toward a second generation engagement simulation system. Such a second generation system could solve gunnery, battlefield obscuration, and other problems by the early years of the 21st century.

ANNEX G

# ENGAGEMENT SIMULATION FOR JOINT AIR/GROUND OPERATIONS

COL Richard I. Edwards, USA (RET)

## G.1. General

The purpose of this paper is not to suggest technical solutions to problems of future engagement simulation, but rather to define a major problem area needing engagement simulation and provide some guidance toward areas where solutions to those problems may be found.

The Department of Defense has recently undergone a significant reorganization, and potential shift in emphasis toward joint operations, with the passage of the Goldwater-Nichols Act of 1986. Improving interservice cooperation and training is one of the chief purposes for this reorganization. Finding training solutions to joint close air support operations is a major worthy objective for the period of 1995 and beyond. In the business of unit air/ground engagement simulation, the Army is in the lead. The Army is currently committed to eye safe laser technology for engagement simulation of air/ground operations, and is likely to remain so for this period. AGES/AD laser equipment is currently being fielded for the National Training Center (NTC) and the entire Army. The Air Force has just begun the process of fielding hardware compatible with AGES/AD for play at the NTC. These past initiatives have been separately pursued by the services, with insufficient sharing of expertise. The next generation of air/ground engagement simulation gear must be developed with joint planning and concurrence in the training assumptions and definitions.

While engagement simulation to date has been practiced primarily at a unit's home station, its use for air/ground operation will probably be mainly at central training sites, such as the NTC. Accordingly, this paper addresses initiatives from the central training site perspective. It is likely that, as costs for future system production are brought down, some of the initiatives discussed in this annex may be deployed at selected home stations for joint operations.

## G2. Focus on Battalion Task Force and Brigade

As part of the training development process creating the NTC, the Army has kept the start up phase focused on the battalion task force. The focus for the JPL study on future engagement simulation should remain at that same echelon. Simulations should maximize realism for the individual through battalion task force. Simulations of echelons higher than brigade can and should be done off-line from the field exercises. Game simulations using data from the field exercises for the models is a recommended approach. Attempting to replicate threats for the

use of hardware found at higher than brigade echelons soon begins to overload the battalion/brigade training scenario, and generates out-of-proportion resource and support requirements.

G3. Current Training Practice.

There are two separate and non-interactive training environments that must be considered when studying air/ground issues: Blue Air against Red Air Defense and Red Air against Blue Air Defense.

a. Blue Air against Red Air Defense

This is the more critical of the two training environments. It is the one that the Air Force is most likely to help solve, and that offers the most training benefits to both services. It is the one, in my opinion, where efforts and funds should be concentrated.

Army AGES/AD hardware is currently limited to systems in the immediate inventory. The most complex system now being fielded is for the AH1-G Cobra. Thus system contains the first embedded training device in an operational weapon system. MILES transmitters are now found in tactical TOW sighting units. Rocket and chin turret weapons systems are also simulated. Detector belts receive incoming laser fire from all the MILES hierarchy, as well as the air defense weapons systems within AGES/AD. Other Army air and ground systems are similar but less complex. Some unique threat systems have been created for training for the NTC, but these systems lack realistic radar signatures and are relatively unsophisticated.

The Air Force has begun to fly some missions at Ft. Irwin in support of the NTC using a prototype pod that can "kill" MILES-equipped ground elements. (Ten Laser Engagement Simulation pods have been bought: two are on site and eight more are pending.) This pod, called LES I for phase I, does not have detectors mounted that react to the fire of those same ground elements. There have been examples of aircraft overflying the enemy by accident or on purpose; such action in combat could easily prove fatal. Army helicopters are vulnerable not only to air defense weapons but all other ground weapons (rifles through tank fire). The Air Force LES II, or phase II pods, will have detectors and play aircraft vulnerability. A solicitation for industry to build LES II pod appears imminent. Systems other than for the A-10. are not presently planned

b. Red Air against Blue Air Defense

The Air Force has built a Red Air Threat for *RED FLAG* air to air operations, but close air support has been lower down the Air Force priority list. The Air Force considers the exercise of the Army's air defense an Army training problem; accordingly they have been reluctant to dedicate many resources to it. (The Air Force considers little practical training return from simulating Soviet pilots operating against U.S. Army systems. A limited number of missions are flown at Ft. Irwin by standard US aircraft, not the RED FLAG Mig-configured aircraf.). The Army has built its own first generation "prototype" air threat (the Hind D helicopter) for use at Ft. Irwin against the rotational task force air defense. The Air Force flys a limited number of red threat missions with US air frames simulating enemy fast movers; as long as it continues to do so, training will probably be adequate for the Army air defense team at the NTC.

G4. Training Implications for Light Force Units

The National Training Center has been the only centralized training site thus far. Fort Irwin was created for the exercise of heavy formations, armor and mechanized infantry. Army emphasis has recently been placed on upgrading the capabilities of the light forces. Some light force units are now being included into the schedule of units rotating to Ft. Irwin to practice combat in a high intensity environment. Active plans are advancing for the creation of a light force NTC, with emphasis on low to medium intensity operations. This facility will be probably be placed at Ft. Chaffee (Arkansas), and is intended for joint operations. It is currently called the Joint Force Readiness Training Center (JRTC). Given the vulnerabilities of light force units, there is an urgent need for a place to practice the skills required for combat in the third dimension. One entire division, the 101st Air Assault Division, is geared for combat with extensive organic helicopter support. Airborne and Ranger forces likewise need engagement simulation practice with a joint and three dimensional battlefield. The JRTC is the place for that practice.

G5. The Need

a. Practice Area for Close Air Support

General Depuy, the first Commanding General of TRADOC, once said "doctrine is what works." Given the complexity of the three-dimensional battlefield, and the interservice coordination necessary, a practice area for that battlefield is necessary to see what "works". Some doctrine has been jointly written by the TRADOC/TAC team, but only

the NTC offers an opportunity to see what "works" in a realistic, and constantly used near real-time casualty assessment system, with fluid ground forces. The realism in that system presently is two dimensional. The addition of LES I and II pods will initiate a critical phase for air/ground engagement simulation. That phase must be fully supported to include full participation by the Air Force and complete appropriate electronic warfare (EW) signatures and actions. Since the EW and third dimension are a mutual threat to Army and Air Force, both must create training support and share in its benefits. Critical three-dimension type problems that could be worked out through practical training are: reconaissance and determination of threat free routes to firing and launch positions; target detection, designation and hand-off (scout-cobra-fighter-artillery); coordination of air space over the battle area; and artillery coordination (enemy air defense suppression, etc.) with fighters and helicopters. Each of these issues represents a complex and difficult task when performed in the dust and melee of large opposing forces. Training in such a situation benefits not only pilots and gunners, but the commanders and staffs who must manage their assets and time, to exploit each service's capabilities.

b. Systems Approach to Engagement Simulation

The current practice of the Air Force for close air support training at RED FLAG at Nellis Air Force Base is unrealistic; ground targets for bombs and rockets are fixed, and don't change from day to day; electronic emitters don't exist on the close air support range; where emitters are emplaced on other ranges, they lack a shoot down capability (it must be inferred by an off-line instrumentation monitor.) The Army threat emitters at Ft. Irwin are few in number and old. They are adequate for training slow moving helicopters, but not fast moving Air Force aircraft. They do not emit radar signatures that allow appropriate training on the Air Force RAW gear. The time frame of this study offers an opportunity to obtain control of this piecemeal process, and allows for analysis leading to a systems approach to the training challenges. Given the future funding shortfalls, it is certain that Air Force and Army requirements must be synthesized, with no duplication of effort.

The components of a total range system are: a real-time casualty engagement simulation system, with all appropriate air and ground weapons simulated; an electronic warfare range, superimposed over the engagement simulation range; and instrumentation for assistance in both casualty assessment and collection of information for After Action Reviews (AARs). The latter components are beyond the traditional definition of an engagement simulation system and warrant additional discussion.

c. Electronic Warfare Range Overlay

Ft. Irwin instrumentation has the capability to measure the length and number of transmissions from all instrumented players. Additionally, all radio transmissions are recorded for playback of security or communications violations. Some limited EW jamming is played, but little is done to replicate the probable electromagnetic environment of the high intensity battlefield. Commanders and staffs therefore rarely give attention to antenna placement, terrain shielding, or command post displacement to avoid enemy counter strikes to intercepted transmissions. The Air Force plays electronic warfare to a much greater degree at RED FLAG, but primarily as it relates to FLOT penetration and deep strikes, with little if any EW played on the close air support range.

What is needed is a specially designed electronic warfare range overlaid on engagement simulation ranges where joint air/ground operations are played. Such a range could take advantage of the existence of range instrumentation towers and possible transmission means. A matrix of directional monitors and jammers could be centrally controlled to replicate threat activities. If properly designed, such a system could be far less expensive than the building of numerous field simulators. Their control would be centralized to assure that training objectives and safety standards during exercises were met. Such a system would not totally replace field emitters. As noted earlier, the detection and neutralization of ground threats to air operations is a critical part of the joint air/ground battlefield. An electronic overlay would tie field assets in, replicate assets from outside the brigade battle area, and provide an effectively controlled ground communications jamming system.

d. Range Instrumentation System

The Air Force has instrumentation for training at RED FLAG. The Army has instrumentation at Ft. Irwin, and will probably implement it at the combined arms ranges planned in Europe and for light forces at Ft. Chaffee. The Air Force and the Army instrumentation concepts (one high data rates for few players, and the other low data rates for many players) should be merged as part of the systems approach to engagement simulation. It is my belief that range instrumentation for all combined arms ranges in the future will be a necessity. Instrumentation provides answers to almost all the problems raised in the JPL TES Workshop. A critical element of any training is the ability to conduct a meaningful AAR. Most of the learning occurs in the environment of the AAR. If behavior is to be modified, nformation which is accurate and believable by the participants of the engagements is critical. While credible umpires can fill some of this need, true credibility demands some mutually acceptable source of data-accurate instrumentation. Much has been

made of the problems of accuracy of the instrumentation at Ft. Irwin. In the time frame discussed in this study, it can be reasonably expected to see substantial improvements in accuracy and decreases in size and costs of player units. These trends are already observable in subsequent generations of NTC instrumentation.

While current cost and state-of-the-art make instrumentation seem less promising than current laser-based technologies for engagement simulation, the speed with which both the processor and communication industries are moving suggests strongly that these fields hold the promise for revolutionary breakthroughs. What is needed is a fresh look at engagement simulation, from the perspective of what a *fully instrumented low cost instrumentation* could bring. Such a system could offer: easy instrumentation installation; cigarette pack-sized player modules; distributed processing for player state; and engagement results in three dimensions. Such a system, with all player modules knowing where other players are, could be particularly effective in solving the obscuration problems plaguing MILES, AGES/AD, and other pure laser systems. It could also provide the basis for data allowing solutions to playing gunnery within engagement simulation, the play of smart weapons, easier control of exercises, and more effective AARs.

G6. Joint Approaches

The Army has been working the problems posed by engagement simulation in the third dimension. Its expertise with AGES/AD can serve as a beginning point for the inclusion of the Air Force into meaningful engagement simulation. The Air Force should support a rapid in-house training development definition of the close air support skills its pilots and personnel in key command/coordination billets (interfacing to army battalion and brigade levels) will need. Once that is done, all further definitional effort must be done jointly with the Army. (TRADOC and TAC seem the proper level to cooperate for joint user definition.) The essential business of definition will be a series of trade-offs between technical capabilities, and their costs. Without a joint effort, and joint funding, unrealistic requirements are likely to be formulated. (Example: How much should ground-to-air bullet trajectory be inserted into the system -and where- in order to give credit to proper fast mover pilot evasive action? What is the cost of that simulation, and what simulation approximations are acceptable to allow bearable costs?)

For its part, the Air Force can bring its expertise in the area of electronic warfare threat simulation. This should be tempered by Army experience in making OPFOR simulators that are similar in appearance and thermal signature to the real threat, mobile and moving as a part of the hostile force. Trade-offs in capability and cost will be necessary. Both sides must find funds to support their

effort and give reasonableness to their defined requirements. Threats should be limited to those found physically in the brigade battle area. Enemy EW systems which impact the brigade area from outside the area can be played by fixed simulators, as they are now in RED FLAG.

G7. Recommendations

a. Systems Approach

**Establish a systems approach to air/ground engagement simulation.** Such an approach must involve both Air Force and Army needs. Concentration should be on solutions to combined arms range close air support engagement simulation **based initially upon technologies within the evolutionary AGES/AD system, and including appropriate EW simulation and position location and data transmission instrumentation.** Focus should be on realistic simulations of systems found within and above the brigade area. **The systems approach should include a plan for the graceful conversion of present laser engagement simulation system to a largely instrumented based system, as miniaturization and advancements in computer and communication technology allow.**

b. Hardware/Software

1. Aircraft vulnerability must be played, with pods developed for all aircraft that are to be used for close air support.

2. A generic aircraft pod should be developed as rapidly as practical, to permit **play of all aircraft likely to provide close air support and simulation of all close air support type weapons.**

3. **Electro magnetic signatures must be included on all appropriate ground threat simulators.** These simulators should have visual and thermal signatures similar to the weapon system they replicate. They should be mobile and move within the threat array (OPFOR) found at the appropriate training center (NTC, JRTC, etc.). Threats found outside the brigade area, but that influence the air space over the brigade area, may be simulated with considerably less physical reality and cost.

4. **A new approach to engagement simulation should be studied, with improvement in capabilities viewed in the light of future possibilities range instrumentation offers.** The approach would be to develop an architecture for engagement simulation as a part of a total range instrumentation package. Among the trends offering

instrumentation breakthroughs are: miniaturization of processors and communications systems; distributed processing among the players; and the emerging position location accuracy and data passage capabilities of satellite-based communications. MAFIS instrumentation architecture and module technologies offer one starting point for such a study.

c. Organizational

1. As an immediate step, TAC representation on the planned TES/PM TRADE Study Advisory Group for JPL should be solicited for future AGES/AD initiatives.

2. Establish a joint working group (reporting to Commanders TAC and TRADOC) on concepts, solutions, and requirements for an expansion of the air/ground engagement simulation. USMC representation can be solicited as, and when, appropriate.

3. Establish joint 4-star briefings concerning progress on the air/ground joint working group initiatives.

## ANNEX H

## SOME CONCERNS AND RESERVATIONS
W.G. McMillan

### H.1 Relevance of Current Tactical Engagement Training

The TES Workshop panel was charged with providing technical advice on the development of training devices to be used in the simulation of tactical engagements of US Army ground forces. It is apparently assumed without question by the Army that the type of engagements (the environment, likely enemy, character of weapons [on both sides], etc.), that have been chosen for training are those most relevant and likely to be encountered in future conflicts. That may be true. However, I feel that I would not be giving my true opinion if I did not express serious doubts concerning the relevance of the types of conflict for which we seem to be training--and, by extension, the aspects of training that should be simulated.

During the Vietnam conflict, there was a severe draw-down on Army equipment in other theaters, particularly in the European Theater of Operations (ETO). It was thus natural, especially after Vietnam, for the Army to do an about-face, and return its primary attention to the ETO. However, it is noteworthy that since WWII, Europe has enjoyed over 40 years without war, a duration virtually unprecedented in modern history. During this same period there have been literally hundreds of peripheral wars in lesser-developed regions around the globe, most sponsored or at least exploited by the Soviet Union. US troops have been involved directly in two of these (Korea and Viet Nam) and US advisors and military equipment have been involved in numerous others.

Thus, although it is clearly necessary that NATO forces continue to constitute an effective deterrent to Soviet expansionism in Europe, the theaters in which US forces appear (to me) more likely to be drawn into armed conflict lie elsewhere: particularly in the Middle East (where Soviet aggression in Afghanistan and ambitions in Iran threaten control of the free world's supply of oil) and in Central and South America and Cuba (where Soviet encroachment through its client states threatens the democracies of the Western hemisphere). Should we not begin to learn how to fight (and, for that matter, conduct and control) low-intensity conflicts involving insurgencies and guerrilla warfare? Viet Nam was the only war that the US ever lost, and we are even less prepared today.

Communist developments for low intensity conflict continue apace:

More effective methods of guerrilla/insurgencies.

Intensified exploitation of terrorism.

Use of helicopters in support of ground operations.

Improved man-portable artillery and antiaircraft missiles.

Exploitation of laser technology.

Introduction of ground-attack aircraft.

Chemical warfare training.

Skillful use of propaganda, disinformation and PsyOps.

In determining the composition, tactics and doctrine of our ETC forces, we largely ignore great changes that have occurred since WWII:

The greatly accelerated tempo of modern battlefield engagements, illustrated by the short but furious engagements of the 6-Day and October 1973 Wars in the Middle East.

The advent of precision weapons (TOW, STAFF, SADARM, the Laser-Guided Bomb, Maverick, HARM, Exocet, etc.).

Remotely-piloted vehicles, for both Intelligence collection and attack.

Artillery shell-back-tracking radars (e.g., TPQ-36 and 37), that will require almost continuous relocation of artillery batteries in order to survive immediate counterbattery fire.

The introduction of several families, continually updated, of Soviet anti-aircraft missiles which threaten to make air operations virtually suicidal--as indeed the Israeli Air Force discovered in the October 1973 War.

Military satellite technology, such as reconnaissance and communications satellites and the Global Positioning System.

Laser range finders.

Night-vision equipment.

Sensors of many kinds.

A new Soviet amphibious capability.

New capability and confidence of the Soviet blue-water Navy.

Highly-developed Soviet ECM and EECM.

A particular worrisome aspect in ETO is the great numerical superiority of Soviet Union/Warsaw Pact forces over those of NATO. One classic method of redressing such an imbalance is to use defensive fortifications to take advantage of the well-established force multiplier (about 3:1) that fortifications offer. One versed in military history might wonder why the development of methods for the rapid construction of field fortifications is not given a high priority in NATO. But clearly, the incorporation of field fortifications into tactical engagement training will never happen unless their use becomes part of the Army's accepted tactics and doctrine.

Although outside the narrow focus of our charter, I feel compelled to underscore the overriding importance of properly forecasting the type of future engagements which our armed forces are most likely to encounter, before reliable decisions can be made concerning what to simulate in training. Question: To what extent does present Army training prepare our forces for a Vietnam-like conflict that may confront us in Central America?

H.2 A Reappraisal

I contend that the whole question of possible future conflicts--involving all major issues, from theater to tactics and doctrine to C3I to weapons--needs to be reexamined in the light of modern developments in both technology and war-fighting methods, for both the uS Army and its possible adversaries. As evidence that such reexamination is needed, I submit that:

The U.S. did not learn in VN, and still doesn't know, how to fight and win against a determined guerrilla insurgency.

Specifically, effective methods for preventing or countering terrorism, like that inflicted by the Viet Cong/North Vietnamese against hamlet and village officials appointed by the S. Viet Nam government, have not been developed.

Land mines and booby traps were responsible for nearly one-third of US casualties in VN. One of the most effective "sensors" were highly trained dogs, but the Army's dog program has been canceled. The development of mine

detectors and countermeasures at Ft. Belvoir has been greatly reduced.

The use of Precision-Guided Munitions (PGMs) that hit the target would greatly reduce not only the ineffective expenditure of ammunition, but also the logistics chain. In Vietnam, the US had only 100 combat battalions in the field (i.e., about 100,000 men) versus 450,000 men in logistics and supporting roles. Yet our annual munitions buy is still dominated by ordinary unguided and inaccurate artillery shells and "dumb" bombs that are very inefficient and ineffective.

With the demise of the Defense Communications Planning Group, that developed the sensor systems for the "McNamara Barrier", the development of sensors for US ground forces reverted to the Army's REMBASS program. The various systems that had been developed during VN for centralizing sensor read-out information in the field, and combining this with other Intelligence to provide real-time targeting, have apparently been lost and forgotten.

Base defense was and remains a largely unsolved problem in the Viet Nam context. We see the same lack of defenses in El Salvador, in which one of their principal training camps has been overrun repeatedly by the communist guerrilla forces.

In trying to interdict truck traffic from North to South VN along the Ho Chi Minh road and trail network, the McNamara Barrier project focused on sensors. Yet the Air Force pilots were insisting that the limitation lay in aerial ordnance that could hit the trucks; they always saw ten times as many trucks as they could strike effectively.

The Army has not developed an adequate replacement for the M-72 light antitank weapon (LAW). This weapon failed miserably (for example, in the defense of Lang Vei against NVN P-76 tanks in January 1968). The follow-on VIPER weapon was cancelled.

It is for these and similar reasons that I doubt that our ground forces are being provided the weapons and training that would be truly relevant and useful in the kind of low-intensity conflict that appears to me most probable.

Turning to the high-intensity conflict envisioned in the European Theater, I have other concerns.

Mechanized Infantry - In the Soviet ground forces the trend in mechanized infantry has been toward vehicles from which the occupants can fight (by firing through port-holes) without

dismounting. They are thus protected (albeit by light armor) from small arms fire and flying fragments. By contrast, the US mechanized infantry uses vehicles like the M113 or the Bradley primarily for the transport of infantry to forward regions, where they dismount and undertake classical foot-infantry operations. Like their Soviet counterparts, the US infantry in transit in these vehicles have a degree of armor protection, but--unlike the Soviet mechanized infantry--are essentially out of action until they can dismount and deploy. Once dismounted, they lose whatever protection the vehicle offered, and become much more vulnerable to modern fragmenting munitions (of the type represented by artillery COFRAM, VT air burst artillery shells and bombs, air-delivered cluster bomblets, antipersonnel mines, etc.). This combination of tactics and vehicle design thus appears to place US mechanized infantry under a severe disadvantage vis-a-vis its Soviet counterpart. Perhaps we should consider returning to the concept--used in some of the earliest WWI tank designs--of providing sponsons on the APCs for side-firing machine guns manned by the troops inside.

Artillery - Mortar and artillery shell-backtracking radars, like the Army's TPQ 36 and 37, can determine the location of the launch site within seconds, and allow counter-battery artillery fire to arrive within 1-2 minutes, depending mainly on the counter-battery shell travel time. In the face of this capability, the artillery needs new and different tactics. There is a premium on rapid fire--getting off as many rounds as possible while counter-battery fire is on the way--but still allowing time to displace the 100m or so to escape from under the incoming fire. In turn, these requirements suggest several desirable features for artillery:

Self-propelled, for rapid displacement.

Automatic loading for rapid fire.

Minimal crew.

Crew contained in the vehicle protected by at least light armor.

Ability for very rapid survey of firing positions (which can be provided by the TPQ 37 itself to an accuracy sufficient for artillery fire).

Individual Weapon - In either low- or high-intensity conflict it seems to me that the individual weapon (the rifle) may have largely outlived its usefulness.

Statistics on the number of small-arms rounds expended per enemy KIA, [shown roughly in the accompanying FIGURE?], are very revealing--and would be instructive if carefully analyzed. What is shown is that small arms are exceedingly inefficient, causing 1

enemy KIA for upwards of 20,000 rounds expended. (Of course, even with this low efficiency many are killed because the total numbers of rounds expended may be in the billions.)

It appears that most of the US small-arms fire is unaimed, and has the purpose of keeping the enemy's head down (suppressive fire) and the GI's morale up. But if that is the case, the design of the individual weapon should be reexamined to see if its capability cannot be better optimized to the purpose for which it is actually used.

As an example, the operational environment of a LRRP or SEAL team in VN was mainly along narrow, overgrown and tortuous jungle trails. Because of low visibility (due to trail curvature, intervening jungle growth, night operations, etc.), most engagements with enemy units encountered on the trail occurred at very short ranges, i.e., perhaps a few tens of meters. The ability of the point man to immediately put the leading elements of the enemy unit out of action largely determines the outcome of the engagement. But as any hunter knows, a rifle--even an automatic rifle--is a poor weapon against a rapidly moving target. In a surprise situation, the problem is compounded by the time required to raise the rifle and aim. In place of a sequence of bullets, what is needed is a simultaneous coverage of the relevant area by a hail of lethal pellets.

The solution adopted by the Navy SEALS was to use a 12-gauge shotgun with a "duck-billed" choke to cover, at a range of 15 meters, a rectangular area roughly 2 meters high by 4 meters wide. If uniformly distributed over this area, a 3" Mag 12-gauge shotshell containing 41 #4-Buck pellets (diameter 0.24") would provide about 5 pellets per square meter; a "long-range" or "field load" shell of 2-3/4" length containing 1 oz of #4 shot (0.13" diam, 136 pellets/oz) would provide about 20 pellets/m2, assuring several pellets in a man-size target.

These doubts cause me to question whether the general plan of Army training is relevant to modern combat--whether against guerrillas or the ground forces of the Soviet Union/Warsaw Pact. And unless the training is relevant, there is little point in simulation, of whatever high-fidelity might be achieved.

Thus I ask whether the engagement of red vs blue infantry forces armed with rifles is what we should be simulating (e.g., with MILES). And in what way are artillery airbursts (simulated by SAWE) relevant to infantry buttoned up in AFVs? It won't wash to argue that US infantry is not buttoned up in AFVs if the enemy is, because that looks as though we purposely expose our infantry to great disadvantage.

The central theme of these considerations is that before we spend talent and resources on simulation in tactical engagement, we should make sure that the type of engagement for which the training is intended is in fact realistic, and not again simply getting ready for a type of conflict that may be largely irrelevant.

# APPENDIX D

## SECTION 5

## MINUTES OF THE FUTURE GENERATION TES SYSTEM MEETING

Minutes of the
Future Generation Tactical Engagement Simulation System Meeting
Jet Propulsion Laboratory, Pasadena, California

Tuesday, April 19, 1988
Building 79 Conference Room

Attendees:

JPL

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|---|---|
| Jack Battenburg | Rosemary Hagerott |
| Bob Beaudet | Jon Inskeep |
| Warren Dowler | Gordon Wiker |
| Dan Griffin | |

Consultants

| | |
|---|---|
| Dick Edwards | Bob Hennessy |
| Rick Francis | |

Jon Inskeep began the meeting at 8:15 by introducing the participants. He asked Dan Griffin to report on the current status of the Simulation of Area Weapons Effects - Indirect Fire Simulation (SAWE-IFS) Project. Dan stated that the end-to-end system verification had been conducted at the JPL Edwards Facility (EF) on Thursday, April 14. At the EF meeting, PM TRADE, the sponsor of SAWE, announced that the IFS project is to be closed out by July 4, 1988. No hardware will be delivered to NTC.

Jon reported the status of the Future Generation TES task. The final report is due to the sponsor (PM TRADE) in June 1988. What JPL needs from the consultant participants is assessment of the availability of technology to meet the nine JPL-defined technology development problem areas:

1. The instrumented platform
2. Smart weapons
3. Simulated gunnery
4. Air defense
5. Artillery and mortars
6. FASCAM
7. MOUT
8. Command and Control
9. Obscurants.

The final JPL recommendations must be practical and useful to the Army and in the context of the prime TES constraint: the user of these TES technologies is defined as a MOS-immaterial soldier with less than eight hours of TES training.

Gordon Wiker discussed the issue of *embedded training*. Embedding training equipment presents the challenge of providing more information than the real weapon does. The question of embedding, therefore, is not addressed solely in terms of cost but rather becomes a question of training philosophy.

Gordon suggested that the Army should have a policy of providing a standard data interchange port on all weapon systems/platforms.

Jon presented a background of the Prioritized Needs Summary (PNS). He categorized the status of TES technologies as:

1. Mature, such as MILES laser pairing.
2. New, such as the SAWE aeroacoustic coupling.
3. Underdeveloped, such as millimeter wave pairing.
4. Undefined.

Warren Dowler made a viewgraph presentation (viewgraphs attached) that outlined the JPL objectives for TES, showed overall approach, results of the PNS, and challenges in designing TES.

A great deal of discussion concerned the viewgraph which showed a structured functional analysis diagram of the interactions in a generic TES system.

Dick Edwards suggested an addition of *time-of-flight* (for enhanced realism) to the four categories of what the troops must know. This is especially necessary for simulation of missile engagements. Time-of-flight could also be defined as a *ranging* problem for TES.

Dick also commented on the diagram flow from weapon volume to target volume. He felt a new area, *firing assessment*, should be defined on the pairing signals interface. He also recommended that casualty assessment be repositioned to the pairing signals area of the diagram. Furthermore, the pairing signals connection should define the transmission media.

Rick Francis felt that it was important that the transmission media be earmarked to show a data link to control not to individual soldiers. MILES is a one-way link; this would open the door to a *two-way link*, which is a big issue in obscuration.

Dick than questioned the diagram in general. He presented a topic for discussion: should TES be considered in two different architectures. TES development could consider the light weaponry (dismounted) in a different way than heavy (armored) weaponry. (Later, a third architecture was suggested: weaponry for air versus ground.)

This topic was discussed at length. Some of the ideas/questions generated were: Should a Venn diagram be incorporated in the final report? How much interaction should there be between heavy systems? light versus light? light versus heavy? What would be the cost results to future TES? A critical issue is the pairing structure: should it be casualty to unit? should it be different for weapons on heavy equipment?

Warren suggested another architecture for consideration: *suppressive fires* as opposed to fires that are targeted. Another long discussion evolved with definition of suppressive fire. Does the "red" team need the same realism as the "blue" team? Does it make sense to provide both teams with the same information? Opinion was divided on this issue.

Dick felt that differences in technical issues in the training, such as tactics and doctrine, do not relate to training blue versus red as much as they do to below company-level versus above company-level.

The viewgraph presentation continued with discussions concerning several areas.

On the subject of *pairing through obscuration,* the Army will be happy if the problem of TES matching the performance of thermal sights can be licked. The technical solutions may solve the critical issues (to NTC) of pairing through smoke and dust.

Discussion of the viewgraph on *smart weapons* covered what the simulation must replicate. There was also discussion about training coordination between the Army and the Air Force. Still unsettled is the difference in requirements for simulation with fixed-wing versus rotary-wing aircraft. Jon reminded the group that the current TES recommendations must satisfy only Army requirements; future joint services effort could be a recommendation for Army consideration.

*Precision gunnery* was discussed. It is important to know the "hit" rate. There will be a strong recommendation in the final report for solving the problem of the high cost of this important area of TES. Dick brought up an important reason for TES to simulate precision gunnery: our skills are our combat advantage; precision gunnery is needed to demonstrate this on the training battlefield. An affordable cost for a precision gunnery system would be 2X-3X the cost of MILES.

The primary issue for *FASCAM* is whether the approach should be a one-for-one replication of mines or just rope off an area and simulate the effects of the overall minefield.

The meeting adjourned for lunch. After lunch, the group broke into three small discussion groups. The entire group reconvened at 4:20. Discussion groups reported on their afternoon sessions.

Dan asked Bob Hennessy to present his idea concerning *augmented training*. Bob said that augmented training promotes learning at a faster rate; it gives more information than "real world". A danger of this is that the player can become too dependent on feedback. The value of augmented training is for use in the *After Action Review (AAR)*. The data generated can be used to support debriefing. The challenge is to be able to translate engagement data into performance measurements.

Dick stated that this is currently a major TES deficiency. The information collection system is integral to TES but does not now adequately support the AAR. He felt that embedding support for the AAR into TES is more important than embedding TES into the weapons. Group discussion raised the issue of how to define the data requirements. (Too much instrumentation leads to too much data to reduce in a practical and timely manner for the AAR. The result is that today very little of the available data is ever used.) The type and level of data collection is very different for different unit sizes: the squad, the platoon, etc. Consensus was that it is absolutely critical to define what is needed before the fact.

The issue of *cheating* was discussed. The Army recognizes that it cannot prevent cheating, but TES systems shouldn't make cheating too easy or too tempting. The philosophy is: if cheating doesn't change the overall outcome, cheating detection is not important.

The meeting adjourned at 5:15.

Wednesday, April 20, 1988
Building 183, Conference Room 343

Attendees:

JPL

| | |
|---|---|
| Bob Beaudet (p.m.) | Rosemary Hagerott |
| Warren Dowler | Jon Inskeep |
| Dan Griffin | Gordon Wiker |

Consultants

| | |
|---|---|
| Dick Edwards | Bob Hennessy |
| Rick Francis | |

The meeting began at 8:15.

Discussion resumed concerning *augmented training*. Too much feedback to the player at the wrong time (such as in real time) could change behavior. It could give better but false results and so could create negative training. Feedback could be defined in categories of training aid or operational aid. It could be beneficial or detrimental. It should be given only early in the training sequence and not in a testing situation. There must be a schedule for withdrawal of the augmentation in the training.

Gordon asked why the *embedded training* could not be carried over into the real world. It could be built into a lot of systems to enhance performance without making one dependent on aids. This may become easier to do as sophisticated weapon systems rely more and more on onboard computers.

The next area of discussion once again concerned the AAR. What is the purpose of an AAR? TES should include data that could be given in real-time to aid in AARs. The current AAR often takes a confrontational approach. If a credible system provided an immediate focus for discussion, it would help the AAR achieve the goal of combat leaders recognizing mistakes and thereby improving performance.

Dick stated that the Army takes pride in allowing innovation and intuition at lower levels. An AAR is a place to show the decision process that solves problems. A collection of the right data should be made available close to the event to enable leaders to modify decisions. The ideal scenario would be: a short exercise, AAR, re-do the exercise.

A map or sketch-oriented output for AAR would be the preferred way to present data. The JPL TES report should open the Army's viewpoint by

making a strong case for embedded support of the AAR in TES through digital imaging and high-speed graphics processing.

Jon asked what kind of data would be desirable to support AARs. Consensus decided the answer as: where the troops are and how they are deployed. Would sensors be used? The essence of TES training should be to present *ground truth* in real-time. A recommendation to the Army should be "don't separate TES from the AAR"; the PNS results support this recommendation.

Dick felt may be necessary to redefine AARs in terms of home station versus NTC use. The idea of using referees and controllers must be changed. The controller should be thought of as an aid rather than as a judge. If the system design is a good one, the controller could be eliminated.

Bob H. asked if useful information comes from tactical radio transmissions. This could involve the developing technology of automated analysis of *voiceprints* to process this vast amount of information.

Rick stated that it is important to ascertain the data you want before you implement the system. It is easy to record all the generated data, the difficulty is in extracting the desired data. This is an up-front system engineering job.

Bob H. offered the idea of videotapes that work on a common time base for use in an AAR. This is an established procedure that is not high tech. It could be used as part of the overall data base.

Dick stated that videotaping is used on a regular basis at the NTC. The major stumbling block is that analysis and editing of the videotapes is a very manpower-intensive operation. It could be feasible for NTC but not for the home station. Bringing information to the 3-D level would be desirable.

Jon wondered if the Global Position System (GPS) will have a serious impact on TES. Will GPS and central computers eliminate the need for MILES-type engagement pairing?

Bob H. answered that more is needed than position location. The laser should not be eliminated. System operation could be simplified in that computation could start from laser designation.

In reference to position location, Dick felt that the instrumentation should be located with the unit tactical radio as it is necessary only to know the position of the unit (squad, etc.). It must be small, accurate, and repeatable. For casualty assessment, it does not matter who shot whom but what squad shot whom.

Discussion resumed concerning precision gunnery. The performance is there but it is too high cost. The challenge is to reduce the cost to a level that would be acceptable by the Army. Good simulated gunnery is basic to results on the real battlefield. Gordon stated that the cost factors could be a trade-off: better skills reduce demands and produce a more efficient, cost-effective training system.

Bob H. asked if the idea is to improve precision gunnery or design a new system. How about using rangefinders instead of retro-reflectors? Another new technology is automatic target recognition: a silent training eye registers like an observer but does not make the crew aware.

Rick stated that smart weapons are the new technology. Two areas of impact are in image digitization and high-speed graphics. A hybrid of digitization and real images could be designed. High-speed processors are revolutionizing this area of technology.

Discussion followed concerning the communication system. It must be pre-filtered and send only coordinates not images. A digital image could use an icon instead of an actual tank; this would reduce the data tremendously. Various technologies will be mixed. Costs will come down as technology enters the marketplace. There have been tremendous advances in avionics: increased power, reduced size, and cost reduction.

A strong recommendation to the Army is that it must have an ongoing task to monitor emerging and developing technologies as applicable to TES problems. When the technology has been developed sufficiently, the Army could fund a specific TES technology application.

Rick felt that the Army does not have the money available to spend on developing what is really a "new" technology. It is more reasonable to pursue the approach of "jumping in" when the moment is ripe. The Army money can then be spent in implementing concepts rather than in developing the technology.

The meeting adjourned at 11:45 for lunch. The afternoon session resumed at 1:00.

Jon recapped some discussion points from the morning session.

The aim of this meeting is to present recommended technologies to the Army concerning TES. An important part of this recommendation will be to cite new technological developments and advise the Army to monitor the state-of-the-art. It will be an Army decision when to adapt the technology to their own particular need.

Gordon asked if it would be feasible to use a short range radio link within the unit to send some of the data for use and/or retrieval. This should be studied and decided.

Rick cited the field of electro-optics. There are many new applications in this field resulting from innovation in design.

Dick again mentioned the issue of architecture for the TES system. Has there been a decision whether to recommend a two-tier or three-tier approach? Discussion ensued. Rick felt the two architecture approach is correct. The proper protocol must be used for the flow of information.

Bob B. stated that technologies could be divided into enabling and implementing. The TES money should be spent in the field of implementing technologies.

Rick listed the new technologies as: *high-speed computer graphics, image processing and digitization,* changes in *electro-optics,* guided wave (*fiber optics*) techniques, *millimeter wave, low dimensional materials* (2-D in structure), and *database architecture.* Closer to proof-of-concept are the *electronic microsensors*: (1) New advances using chemical sensors; natural radiation can be detected but not tagged. (2) Surface acoustic wave microsensors are inexpensive, selective, and draw very little from the battery. They can be made to be sensitive to a specific area. (3) Optical-fiber microsensors are quantifiable and selective; they can detect acoustic signals, have excellent magnetometer applications. (4) Metastable ferrite could be fired in the field. This might have an application for FASCAM.

Dan wanted to discuss something unique to TES: cues. The area for development is the simulation of flash/bang/smoke.

Warren said that MILES has a realistic hit cue. The near-miss cue is inadequate. A realistic cue is desirable because it is more motivational.

Dick wanted the firing cue for recoilless weapons and rocketry to be retained because of the realism. Also, the Hoffman device used on the tanks is a good cue. Some discussion resulted as to whether blanks are still necessary for the M16. It is valuable to continue training with blanks because soldiers deal with the same problems as in real fire: jammed clips, limitation on the amount of ammunition, etc. What about grenade simulation? The PNS replies showed interest in this area primarily for MOUT. The problem with grenade simulation becomes one of safety. It is difficult to train the throwing technique if the weight is not "real"; the weight then becomes a liability factor if a soldier is hit by the simulated grenade.

Of the flash/bang/smoke, which is the most important cue? At different times (day versus night) and depending on type of weapon, each cue has its own importance.

Dick asked about the status of remote piloted vehicles (RPVs)? Could they be used as part of TES, specifically like a "super SAWE" to deliver indirect fire over 3000-4000 meters ranges.

Bob H. presented the concept of a laser on a RPV that could attrit players on the ground. The element of surprise would have to remain. The RPV would have to be in an operating mode of "loiter" so it did not become a predictable indicator to troops. The Canadians are experimenting with both microwave- and solar-powered RPVs.

Jon thanked all the participants for their interest and ideas. Minutes of the meeting will be issued to participants for their review and comments.

The meeting adjourned at 5 p.m.

Distribution:

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J. Battenburg
R. Beaudet
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J. Inskeep
R. Martin
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ATTACHMENT 1

MEETING VIEWGRAPHS

# JPL

## Command and Control

- Refer to PNS topic:
  - 0. COMMAND AND CONTROL.
- Technology Development Problems:
  - Storage, analysis, and management of massive amounts of data.
- Technology Development Candidate(s)

JPL

# Obscurants

- Refer to PNS topic: S. OBSCURANTS
- Technology Development Problems.
  - Light Cover.
  - Smoke and Dust.
- Technology Development Candidate(s)

ADDENDUM TO MEETING MINUTES

# Augmented Feedback in Tactical Engagement Simulation

Robert T. Hennessy
Monterey Technologies, Inc.

Tactical Engagement Simulation (TES) is designed to be a safe, but otherwise realistic, battle environment to train combat skills of individual soldiers, crews, units, and leaders. TES derives from the premise that certain skills and knowledge cannot be attained to the desired degree of proficiency in other training environments such as a classroom or live-fire range; the interactions of the full milieu of the battlefield are considered essential for particular kinds of learning.

All developments to support TES, such as MILES and the prototype JPL SAWE system, are designed to meet two objectives, to be safe and to provide realistic engagement cues and functions. Although realism is a sure means to achieve the combat-skills learning objectives, it is not necessarily also the most efficient means for training. The real world does not always offer the optimum conditions for learning.

All learning depends on feedback, i.e., perceiving the consequences of an action (or inaction) and repetition of the action - feedback cycle. Moreover, the effectiveness of feedback depends on how quickly it occurs after the action and how clear and informative it is. The real world does not always provide clear, complete feedback in a timely manner.

For example, when shooting a rifle into the woods a soldier may not see where the bullets are striking or if the target was hit. Without this feedback, the soldier will learn nothing about aiming, what is a good rate of fire, and the probability of hitting the target. Field exercises with blanks, then, provide no training on employment of a rifle in combat. A second example is a company commander calling for artillery fire on an suspected, but unconfirmed enemy position. If the enemy cannot be directly seen, the commander learns nothing about the effects of indirect fire on the enemy. He gains no appreciation of the attrition, or if the fire caused the enemy to withdraw.

In both of these real-world instances, no learning (of certain skills) occurred. The same can be true in realistic training if weapon engagement effects are not simulated or the results are unknown. A good TES environment should provide clear, complete and timely feedback as well as safety and realism. Systems such as MILES and SAWE do provide weapon effect feedback and it is one reason they are thought to be such good training tools.

Training in TES can be improved in terms of being made more efficient by providing better feedback at all levels from individual soldier to the Blue Force commander. This can be

achieved by adding feedback elements to the TES that do not occur in the real world. Using unnatural, but effective cues to promote learning is, in a strict sense, departing from realism, but the result is an enhancement not a detraction from the training value of TES. The technological development agenda for TES should include means for achieving augmented feedback as well as safety and realism.

Augmented feedback is a technique commonly employed in training devices. The "training wheels" on children's bicycles provide information as well as physical support when a child tilts too far. (Preventing a fall allows learning to continue and therefore to be accomplished more quickly). In flight simulators, demarcating a desired flight path, such as a landing approach path, has been shown to be a valuable training technique. However, as with all techniques, there are certain principles that must be followed for the technique to be effective.

Augmented feedback can take two forms: a) confirming correct performance, or b) indicating error. Both will work. When augmented feedback is used to confirm correct performance care must be taken to insure that a person does not become dependent on the augmented versus the natural cues to perform the task. In this case, a schedule for withdrawing the the augmented feedback is necessary. This problem is avoided if augmented feedback takes the form of providing error information. The feedback can be arranged to occur only when a certain magnitude of error is reached. For example, a radar operator may receive notice that a target is present only after it has gone undetected for several sweeps. The good points of error contingent augmented feedback are that no unnatural cues are present if performance is relatively good and that an individual cannot become dependent on the unnatural feedback.

Another principle of using augmented feedback cues s that it should be more clear and complete than the natural cues; that is, it should be easily apprehended. Also, augmented feedback should be more timely than natural feedback when possible.

Providing augmented feedback to enhance training effectiveness, or, in short, augmentation, can potentially be applied in several ways in TES. Examples for individual and crew gunnery are the most obvious, and to some degree are inherent in the MILES system. However, some enhancements to this useful system can be envisioned. For example, providing miss distance or information that a soldier's rifle fire has inflicted an enemy casualty would be beneficial to training.

Augmentation can also be used for leaders and commanders. At present, feedback about the effects of decisions occur only in subsequent unfolding of combat events. Often decisions are made based on incomplete or inaccurate intelligence about enemy dispositions. Shortly after a decision is made, revealing the ground truth, and or inevitable outcome of a decision, would provide better more efficient learning for the leader

(particularly if the original decision would produce catastrophic results and the exercise would terminate).

Some caution must be exercised in providing augmented feedback about the outcomes leadership decisions. Decisions should not be made for the leader nor should the leader become expectant that help will be available. This would violate the principle stated above regarding not fostering dependence on augmentation. The feedback to the leader should be objective, i.e., not simply another (even if more experienced) officer's opinion. It should also provide information that would not otherwise be naturally available. For example, the unfolding consequences, casualty by casualty, of an artillery attack (given or received) would be a form of augmentation that would give the leader a better future appreciation of the artillery effects that he would be unlikely to get without many exposures.

The After Action Review (AAR) at the National Training Center is the principal form of feedback to the Battalion Commander and is a form of augmented feedback. It includes many details and observations that would not ordinarily be available in real combat or would not be available so quickly. Methods for enhancing the AAR with additional augmentation would be a useful undertaking. Rapid distillation of objective data and edited and selected video sequences are potential means for improving the AAR.

Augmentation during the course of an TES exercise is probably more appropriate for home base training than at the National Training Center (NTC). The NTC training is really a test. Providing unnatural information during the exercise would affect the commander's behavior and make his performance difficult to evaluate. At the home station, however, where the emphasis is on training more than evaluation, augmentation could be very valuable at all levels including company and battalion command.

Augmentation should be thought of as a training multiplier for realistic TES because it that can more efficiently build combat skills to a higher level of proficiency than is possible with natural cues alone. Technological developments are essential to realize the benefits of augmented feedback. By definition augmentation is artificial and the usefulness of the this training enhancer will depend on clever and innovative technology.

# NEW TECHNOLOGIES FOR APPLICATION IN TACTICAL ENGAGEMENT SIMULATION

A. H. Francis

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## INTRODUCTION

The objective of this section is to identify some new technologies that may find application in future generations of Tactical Engagement Simulation (TES) systems. The effort is guided by the prioritized needs for TES technology determined from JPL's survey of army organizations and of TES suppliers. The prioritized needs were presented by JPL staff during a two-day briefing and workshop on TES problems. Specific simulation problems were identified for precision gunnery (ranging, lead, ballistics, burst on target), for smart weapons (loitering, fire-and-forget), and for simulation in obscured training areas. TES-relevant technologies which offer the possibility of being embedded in weapons systems are of particular interest. Other important considerations include the dominant issue of training safety for both players and operators, cues (flash, bang, smoke), location fidelity, time fidelity, Real Time Casualty Assessment (RTCA), and affordability.

The time available for the workshop and follow-up study did not permit detailed analysis of technology related to each of the prioritized needs. Rather, with these issues identified as general background, an attempt was made to identify some current and developing technologies that might be supported because of potential future importance to TES.

Because of the widely varying types of weapons and simulation

strategies, TES systems are extraordinarily diverse and encompass many types of technology. Therefore, some stratagem is needed to focus analysis on the more central technology issues. The scheme adopted here is to describe a TES system in terms of generic technological sub-systems. Then, to briefly comment on the separate technologies within the sub-systems. In this fashion, it is hoped that some areas of "high impact" technology can be identified.

Any TES system will likely have all or some of the following sub-systems, interconnected in different fashions according to a particular architectural plan.

Communications and Control: Information is passed directly between players, and/or between an individual player and central control. The information could include position, weapon type, status, wind direction and velocity, etc. [We exclude from this category the actual weapon simulation hardware (e.g. laser and photodetector) even though it is generically part of a communications system. However, it is in fact not a necessary part. If range, pointing direction and player position information were available, 'hit or miss' could determined remotely.]

Weapon Simulation Hardware: This is the actual transmit and receive (T/R) system employed to simulate a weapon (laser, mmwave, acoustic). Almost every T/R scheme that might find application in a TES system is already employed in actual weapons systems for ranging, target acquisition, guidance, etc. T/R function for the weapon or for both the weapon and the target are required.

Cues: These are considered as separate and subordinate

to the weapon simulation hardware for convenience of discussion. Cues may considerably increase the complexity of a TES system, if only because additional safety issues arise. The safety hazards created by realistic cues are separate in severity and kind from those presented by the weapon simulation hardware. The following discussion does not address cues in TES since many of the technological problems are of a distinctly different nature.

Sensor, Transducer, Actuator (S-T-A): At the component level, the S-T-A technology will determine the T/R scheme to be employed and the type of information obtainable from simulation.

*Dataprocessing*: Potentially, enormous amounts of data are involved in a highly instrumented simulation (variety of weapons, player positions, conditions, etc.). The data processing system must efficiently handle the large data files from individual players, make RTCA based on validated algorithms and make a variety of control decisions. Algorithms are required for generating a casualty or damage assessment. Optimally, the weapon and target should be uniquely paired with good time and location fidelity, and the casualty assessment should be accomplished automatically in real time.

To a limited extent, underdevelopment of technology in one key area can be compensated by burdening another area. There are "hardware" solutions for "software" problems, and contrawise... poor casualty assessment algorithms may be compensated by increased player instrumentation, but such trade-offs rapidly reach a point of

diminishing return. We will argue that underdevelopment of technology in any one of these areas serves as a "bottleneck" to the development of an optimized TES system.

It is not too difficult to examine these technological "building blocks" of TES systems and then identify a few of the new and emerging technologies that may serve better than existing ones. It is considerably more difficult to offer estimates of development time, availability and cost. Development time and cost are often strongly coupled to the type and number of potential applications of the technology. The anticipation of widespread utilization in consumer products or expendable military systems will speed development and lower unit cost both through rapid amortization of development costs and through high volume production runs. Detailed analysis of these important considerations probably falls under phases of the JPL task associated with tradeoff analysis and BTA.

## COMMUNICATIONS AND CONTROL

The basic function required of TES is the simulation and interpretation of a weapon's effect and application of the data obtained as an aid to training. To achieve this, information must be exchanged at least between weapon and target, and possibly between weapon, target and central control. TES system architecture varies in the manner, type and volume of the information exchanged. It is clear that the TES system architecture will be constrained by underdevelopment of technologies for high-speed, networked communications between players and central control. This is a primary constraint, since in principle, if players could be fully instrumented for position, pointing direction, velocity, etc. and placed in real-

time communication with central control, then many of the problems associated with range, lead, fire through cover, etc. could be addressed by centralized computing. But, the requisite instrumentation is either not available, or available at too great a cost, power or weight burden; communications technology is inadequate to the task for even a modest number of players; and dataprocessing algorithms are not validated for the variety of weapons and battlefield conditions envisioned.

In order to assess the current status of communications in TES, we consider two TES systems with fundamentally different architectures: the "distributed" MAFIS/TWGSS system and the "stand-alone" MILES/SAWE system.

The Mobile Automated Field Instrument System (MAFIS) represents a first-generation, "distributed" system architecture, in which each player is equipped with a Universal Field Element containing (at least in principle) a player position locating function, a data processor for RTCA and a communications module. All players communicate through a field communication network via a central communication/control center. The distributed architecture allows parallel processing of TES data and is probably the only architecture capable of real-time processing of the voluminous datafiles that would be generated by even a small force with full sensor implementation. MAFIS represents the most sophisticated and ambitious TES architecture, but one that places a heavy burden on rapid, high-speed communications. It probably can not be full implemented within the limits of current technology. It should be noted that the instrumentation required for MAFIS/TWGGS is not demountable or man-portable.

MILES/SAWE systems represent a less ambitious TES architecture than MAFIS/TWGGS, but an architecture that was tenable by cleaver

engineering within the current technology base. Each player is equipped with a Player Detection Device (PPD) which is capable of RTCA but does not communicate with other players. The MILES/SAWE Player Detection Device receives IR and acoustic signals. Other I/O could be implemented which might simulate CBW effects. No data is collected by MILES//SAWE for after action review. By permitting algorithms stored on board the stand-alone PDD in ROM to make all RTCA, the need for high-speed communications is relaxed. The obvious penalty is adaptability of the algorithm in real time for changing field conditions, weapon type, protective posture, etc.

The distributed TES architecture probably is capable of addressing all the present requirements for TES as set forth in JPL documents. However, its implementation relies on technologies that are currently underdeveloped. For example, the distributed MAFIS system is precisely analogous to a computer Local Area Network (LAN). Communications software and the architecture for LANs (Star, Token Ring, Buss and others.) are still an area of intense development activity. Most research is focused on efficient "collision avoidance" and "message passing" schemes.

## WEAPONS SIMULATION HARDWARE: Base Technologies

Monolithic Microwave Integrated Circuits (MMICS): The utility of lasers for line-of-sight communication has been heavily exploited in TES weapons simulation hardware. While this technology is excellent for direct fire simulation, it can not address the important problem of battlefield obscuration. This is an area where millimeter wave technology offers potential solutions.

In mm-wave technology, some recent advances are worth noting for their

potential applications in TES. Since about 1982, there has been a very rapid growth of GaAs monolithic microwave integrated circuits (MMICS) as evidenced by articles in technical journals and papers at workshops and professional meetings. Although MMICs are not in quantity production, it is generally believed that the first commitment for large scale production will result from an application in a military system and many military systems have already been identified that will benefit from MMIC technology. Applications have been identified in radar, electronic warfare, precision guided munitions and communications.

More specifically, GaAs MMICs could be employed in the transmit/receive (T/R) modules for active element phased arrays, in broadband expendable jammers and in mm-wave sensors for precision-guided munitions. The low power, low cost, T/R function required for the repeater type of expendable jammer (active repeater decoy) is representative of the technological developments that could find applications in TES. The requirements are similar: a low power, low cost, T/R function in an man-portable module.

The function of the repeater decoy and smart weapon sighting system are essentially at the heart of a TES device. For example, the repeater decoy must: receive a signal (hit) from a weapon system, (2) respond with a signal to the weapon system which then (3) computes range and target information. All these functions are required of TES. Power amplifiers and low noise amplifiers with performances approaching the necessary requirements have been produced at least in prototype quantities. A number of companies have developed prototype quantities of X-band MMICs that perform the microwave functions necessary for the T/R module. It has been projected that a chip set (single-channel receiver) for shoot-to-kill sensors will be available in the 1988-89 time frame. A monopulse receiver and selected low

power transmitter chip set will be available in the 1990 to 1992 time frame.

As GaAs wafer processing technology matures, it will support a higher level of practical chip integration. A typical X-band MMIC chip (for example a two-stage power amplifier) can be processed from a 3-inch wafer of GaAs using today's state-of-the-art technology at a cost per chip of $186. The cost of a MMIC X-band T/R module is estimated to be about $300. Individual MMIC chip costs will range from $12 to $33 for an X-band MMIC to be used in a T/R module to $42 for a wideband chip. A single chip will typically contain circuit functions that were formerly realized in waveguide or with hybrid integrated circuits. These costs do not appear unattractive when compared to the cost of the VLSI protected chip and acoustic transducer in the SAWE PDD.

New Electronic and Opto-Electronic Materials: MBE and CVD materials are new semiconducting materials with a two-dimensional or layered structure, prepared by Molecular Beam Epitaxy or Chemical Vapor Deposition, respectively. These materials can be micro-engineered to have special band-gap properties and unusual electrical characteristics which may make them useful in a new generation of IR coherent source and detection devices. The IR detectors offer higher sensitivity and substantially lower-noise than conventional diode detectors for IR. The lower noise characteristics may permit operation of the detectors at ambient temperatures with detectivities comparable to presently available cooled detectors. In addition to savings in cost, weight, and complexity, improvements in detectors will allow reduction in the irradiance levels required for IR ranging, siting and weapons effect simulation. The reduction in irradiance levels results directly in less interference between different simulation systems and in improved eye safety. A Geiger mode avalanche photodiode has already been employed for very high precision

laser ranging at very low light levels and several evaluations of the technology for this application have appeared.

The modification of bulk properties through band gap engineering is a major development in solid-state electronics and photonics which will dramatically effect the fields of photodetectors and lasers. It is already possible to construct avalanche photodiodes with statistical noise several orders of magnitude lower than attainable in conventional avalanche diodes. The "staircase" avalanche photodiode, constructed by MBE methods, is expected to provide a true solid-state equivalent of the photomultiplier operating in the 1-10 micron range. MBE photodiode devices have been constructed with a dark current of 800 pA, a uniform quantum efficiency over the photosensitive area and linear amplification of x19 with an integrated monolithic FET (Wada, 1983). The band edge discontinuities of heterojunction APDs make the devices potentially faster than similar abrupt structures. Fast response with a full-width at half-max. of 250 ps and no tail have been demonstrated (Capasso, 1983) as well as low dark current combined with large photocurrent multiplication characteristics (Susa, 1984). High-speed response to 10 GHz with gain feedback and an avalanche gain about 60 with 4 nA dark current have been achieved in an MBE fabricated device (Capasso, 1984).

Band-gap engineering is also producing new families of semiconductor lasers. The two most promising structures are the graded-index waveguide in which propagating light and injected carriers are confined to different layers and lasers with multiple quantum-well active layers. These techniques provide improved noise characteristics, lower divergence, much higher output powers and a wide range of operating wavelengths depending upon fabrication dimensions. These new devices, made possible by MBE, have characteristics not achieved in conventional devices (Tsang, 1984).

Some of the characteristics of MBE lasing materials include emission wavelengths 5-6 microns at 10 mw (Parton, 1984), side-mode suppression ratios of greater than 200:1 (Hong, 1985), external quantum efficiencies of 80% and stable, single lobed far field patterns with a beam divergence as narrow as 0.8 degree for a 100 micron laser (Larsson, 1986).

## CUES

The technology for realistic cues is outside the author's area of expertise. We will only note that, in large part, the implementation of cues depends upon the communications and weapons simulation hardware discussed elsewhere in this section.

## SENSORS, TRANSDUCERS AND ACTUATORS

TES requires input and output from transducers and sensors which is processed to interpret and evaluate various weapons effects and which drive a variety of actuators for cues and other signals. Infrared and optical sensors detect direct fire hits by laser weapons (MILES), and acoustic sensors detect surface area weapons effects (SAWE). Chemical sensors may be employed to detect effects of simulated chemical weapons. Thus, any technologies which impact sensor or transducer applications are likely to be important for TES applications.

Because of widespread need for sensors for biomedical, robotics and consumer device applications, advances in the field are frequent and dramatic. Improved sensitivy and bandwidth of E/M devices; sensitive and specific chemical sensors; miniaturization and integration of

sensors, are all related to TES technology. The engineering possibilities, however, depend not only upon the technology of the hardware components, but on the artfulness of its application. The utilization of aeroacoustic effects in SAWE simulations is an excellent example of the inter-relationship between new technology and artful implementation.

Integrated Sensors: Micro-machining by chemical or ion-beam methods permits the integration of transducers directly on silicon wafers. At present, micro-etched silicon inclinometers, pressure transducers, radiation detectors, accelerometers, and temperature sensitive components have been integrated with silicon based micro-circuitry for amplification, filtering and data-transmission (Wise and Clark, 1985). Integrated sensors and interface electronics have been reviewed by Wise (1985). In the near future, it is likely that additional micro-machining capabilities will permit more transducer functions to be carried on-board a micro-chip. The cost of micro-machined components drops rapidly with quantity production as the technology finds broader application, particularly in military and consumer devices, costs/device will be attractive. This technology is potentially important for simulations since it permits sensing a wider range of inputs for TES with lower power, lighter weight, lower cost, and more reliable equipment. In addition to sound cues, integrated sensors could determine a players protective posture (standing, prone, MOPP heat stress, etc.). This information could be used in algorithms to determine the weapon's effect. Of course, additional data to be processed places an increased burden on the TES computer system architecture.

Optical Fiber Sensors/Transducers: Fiber optics and optical guides (sheet and strip materials) have been dramatically improved by the communications and the solar energy conversion industries.

Improvements in both manufacturing techniques and materials have resulted in high "gain" optical antennas and less lossy optical transmission. Furthur improvement in these materials can be anticipated. This technology would allow low cost proliferation of optical sensor systems. Multi-furcated fibers are currently employed to feed multiple (individually coded) inputs to a single sensor element in an array detector.

Optical fiber sensors can be categorized according to the way in which the light is modulated: phase, intensity, wavelength and polarization modulation are possible. Mechanical, electrical, magnetic, thermal, radiation and chemical effects, all interact with the fiber to produce changes in the absorption or transmission of light. Thus, optical fibers offer the opportunity for sensing optical, acoustic and chemical effects in simulations.

An advantage of using an optical fiber is high sensitivity (particularly for phase modulation, such as in the gyroscope or acoustic detector). Transducer types can be intrinsic, in which the fiber itself acts as transducer, or extrinsic in which the optical transducer is separate. Optical fiber sensors can be in the form of a distributed sensor (in which case light is modulated along the whole length of the fiber) or a point sensor. Spectral filtering with optical fibers is possible and a large number of types of spectral filtering sensors can be constructed. Optical fibers for the 2-11 micron range are of particular interest for TES and have been reviewed by Parant (1984). Materials, applications and fabrication methods for IR fibers have been discussed by Bendow et al. (1984).

Whether for mechanical, electrical or chemical sensing, a potential advantage of an optical fiber based system is to be found in its distributed nature. This offers an important advantage for TES since

one obtains a knowledge of the spatial distribution of the measurand. This important attribute has been evaluated by Rogers (1986). Fiber optic sensors offer a number of unique features which make them attractive for a variety of applications in TES. For example, a fiber-optic sensor is be immune to electromagnetic interference, is nonelectric, is compatible with fiber telemetry, can be very sensitive as well as being small in size and weight, and may be used in the development of sensor arrays. Fiber sensors have been considered for the measurement of a large number of physical parameters, ranging from temperature and pressure to rotation rate, magnetic field, position, orientation, chemical concentration and even nuclear radiation. It may be of interest to note that fiber optical guides are employed commercially to monitor position and location of hand and arm. A fiber is anchored at both ends to an interface chip and runs the length of the arm or finger. Each cable has a light-emitting diode at one end and a phototransistor at the other. Cables are treated so that light escapes when the arm or finger flexes. This type of application could be developed to monitor firing position.

For simulations, fiber guides with plastic disk antennas could replace the present MILES belt. The fiber guides have been incorporated directly into the fabric of apparel. Fibers can be woven into fabric, included in surface coatings (paint) and sheet materials can be applied for large-area surface detectors (on trucks, tanks, helicopters, etc.). Doping of the plastic optical antennas with various fluorescent or absorbing materials has been used to make wavelength selective antennas. In this fashion, individual PDDs could be made sensitive or insensitive to different weapons illuminators.

Optical guide materials could reduce the cost and weight burden of the detector array used in the MILES system while permitting a greater number of array elements. Increasing the number of active array

elements, in turn, permits more meaningful simulation of weapons effects from the illumination pattern decoded.

The array detectors themselves can be integrated directly with micro-electronic chips (integrated optics) to form a single, inexpensive, package PDD. Fiber optical sensors could be convenient add-ons to the MILES system, not requiring a change in the PDD itself.

Integrated Optics. Integrated optics is an area of technology of potential importance for TES. Because the present MILES TES system employs infrared detectors, add-on devices have utilized an infrared output transducer to communicate with the MILES PDD. There are opportunities for construction of microsensors with optical or IR output. Integrated optics permits direct assembly of the optical input/output transducer on the silicon based data-processing chip. For example, fabrication of an integrated, large area, planar optical-waveguide chemical vapor microsensor has been demonstrated (Giuliani et al., 1986). A highly transparent polymer served as both the light guiding structure as well as the chemical sensing coating element. The sensitivity to $NH_3$ and PhMe vapors, which could be used to simulate chemical warfare vapor hazards. Such a device is light weight (chip-size), low power, and could easily be integrated into the MILES/SAWE system. It is one representative of a large family of micro-sensor devices.

A number of devices are being investigated at the US Naval Research Lab for their potential application as very small inexpensive, and sensitive detectors of chemical vapors. The technologies being developed include surface acoustic wave (SAW) devices, optical waveguide spectrometers, and vapor sensitive organic semiconductor films. The principles behind the operation of these devices, some experimental detection systems which use them and typical performance

characteristics have been described (Wohltjen, 1983). New developments in chemical microsensors and ultraminiature chemical instrumentation have been recently reviewed by several investigators. Chemical microsensors based on surface impedance changes in semiconductors have been discussed in several reviews.

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# APPENDIX E

# STUDY OF CURRENT TECHNOLOGIES FOR PAIRING THROUGH OBSCURATION

7070-69

# SIMULATION OF AREA WEAPONS EFFECTS (SAWE) TACTICAL ENGAGEMENT SIMULATION (TES)

# A STUDY OF CURRENT TECHNOLOGIES FOR PAIRING THROUGH OBSCURATION

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# A STUDY OF CURRENT TECHNOLOGIES FOR PAIRING THROUGH OBSCURATION

## I. INTRODUCTION

The Army has an urgent need to maintain its troops in top military readiness using a training system that is realistic, safe, and economical. The Multiple Integrated Laser Engagement System (MILES), built by Loral Electro-Optical Systems, is currently being used by the Army to achieve a measure of realistic battlefield training. However, MILES has one very serious deficiency: the gallium arsenide laser used to simulate battlefield weapons cannot penetrate some training battlefield environments and thus engage targets which can be seen with thermal sights. This deficiency makes it difficult for the troops to have a realistic training experience when obscurant smokes are used, or dust clouds have been generated by the maneuvering vehicles.

This report is the result of a review of some of the work already completed, or proposed by industry and by the Army, to solve the problems associated with pairing weapons and targets through obscurants in field training exercises. A matrix summary which lists several pairing concepts, their descriptions, their advantages and disadvantages, and other information, is presented as Appendix A. A summary which lists some of the problems associated with other pairing concepts and identifies areas needing further development is presented in Section VII. A recommended approach to pairing using existing technologies is presented in Section IX.

The effects of the natural environment at sea level and four common Army obscurants were the main considerations in determining the windows of transmission defined in this report. The concentration of water vapor is assumed to be very low, less than 1 $gm/m^3$. An extensive study of the effects of fog, rain, and, most importantly, dust were beyond the scope of this report due to the lack of existing data.

## II. STATEMENT OF REQUIREMENTS

The basic concept of MILES pairing involves the use of eyesafe laser transmitters to simulate battlefield engagements involving the firing of direct fire weapons. The lasers are mounted on the weapon platforms and discrete detectors are located on targets. Ideally, the detectors represent a realistic hit-zone profile that conforms to the general size and shape of the target. The laser beam is adjusted to approximate the impact pattern and range of the simulated weapon and its ammunition. The laser is actuated with each trigger pull. Detectors on the target receive the coded laser signal which contains information such as the type of weapon and ammunition. The coded message is processed by software in the target receiver to assess whether the shot was a hit, near-miss, or kill.

In addition, the obscurant pairing system must satisfy the following:

1. . system must not compromise personnel safety.
2. The transmitter must be capable of matching thermal sight capability in penetrating battlefield obscuration.
3. The system must be affordable, rugged, user-friendly and easy to maintain.

The goal is to develop an obscurant pairing system that will be interoperable with MILES and that will provide force-on-force engagement training when the targets are obscured by the battlefield smoke and dust environment.

## III. MEDIUM CONSIDERATIONS

A successful transmitter for a pairing system must be capable of transmitting through an environment which includes both the natural environment and man-induced obscurants. By combining the effects of water vapor, uniform mixed gases and ozone on the transmission of electromagnetic radiation, in the spectral region roughly between 1 and 13 microns, the following windows were identified (References 1 and 2):

1. 0.77 to 1.10 microns
2. 1.18 to 1.30 microns
3. 1.50 to 1.77 microns
4. 2.10 to 2.40 microns
5. 3.35 to 4.15 microns
6. 8.20 to 13.00 microns.

The extinction coefficients for four different types of commonly deployed obscurants (chlorosulfonic acid, fog oil, hexachloroethane and phosphorus), compiled from data in Reference 2, are shown in Figure 1. It should be noted that, due to personnel safety considerations, the only type of smoke permitted in training exercises is fog oil aerosols. Also, the effects of dust, common on the maneuver battlefield, are not included in these data. The transmission of electromagnetic radiation through a particular medium is an inverse function of the extinction coefficient for that particular medium at the radiated wavelength. Thus, lower extinction coefficients correspond to greater penetration capability by the radiation.

It can be seen from Figure 1 that the maximum extinction coefficient for smoke occurs in the wavelength region less than 1 micron, and that the extinction coefficients generally decrease rapidly with wavelengths up to 4 microns. In the wavelength region between 3 and 13 microns, the behavior of the various types of smoke exhibits no predictable trend. However, beyond 4 microns the extinction for all four obscurants is less than 0.45 meter$^2$/gram.

The combined effect of natural atmospheric conditions on electromagnetic radiation transmission and that of the commonly deployed obscurants are considered in determining the best wavelength for a transmitter source to operate. In the wavelength region between 0.4 and 14 microns, the window most preferred for laser pairing through the combined obscurants would be in

the interval between 8 and 14 microns. This window is almost identical to the 8.2 to 13 microns window resulting from the combined effect of water vapor, uniform mixed gases, and ozone for the ambient atmosphere.

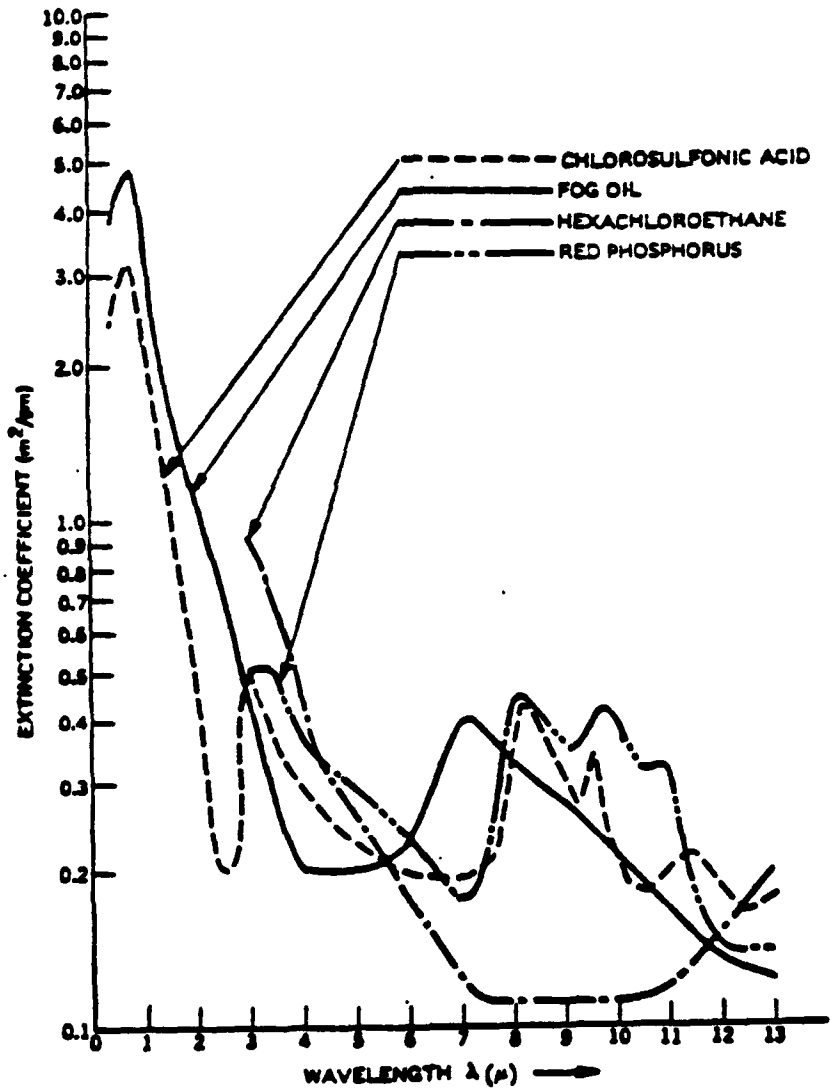



Figure 1. Smoke Extinction Coefficients
(Reprinted from Reference 2, page 13.)

The atmosphere in the wavelength region between 14 and 1000 microns is dominated by carbon dioxide and water absorption bands and thus has no suitable windows (Reference 2).

In the wavelength region between 0.75 mm (400 GHz) and 10 mm (30 GHz), the ambient atmospheric attenuation is due primarily to the components of water vapor and oxygen (see Figure 2). The combined effect of these two components on atmospheric attenuation predicts windows which have minimums at 240, 140, 94, and 33 GHz, as shown in Figure 3 (data from Reference 2).

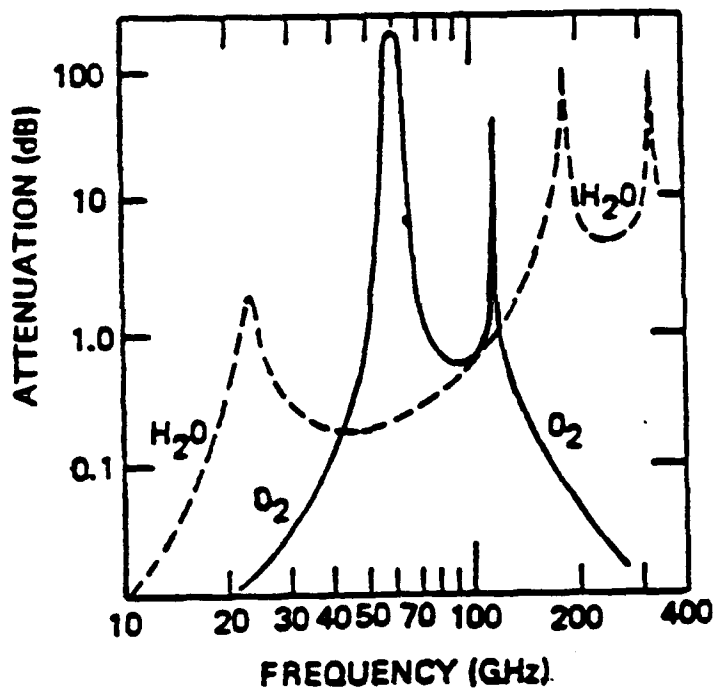



Figure 2. Prediction Chart for Atmospheric Attenuation of Oxygen and Water Vapor at Sea Level (Reprinted from Reference 2, page 32.)

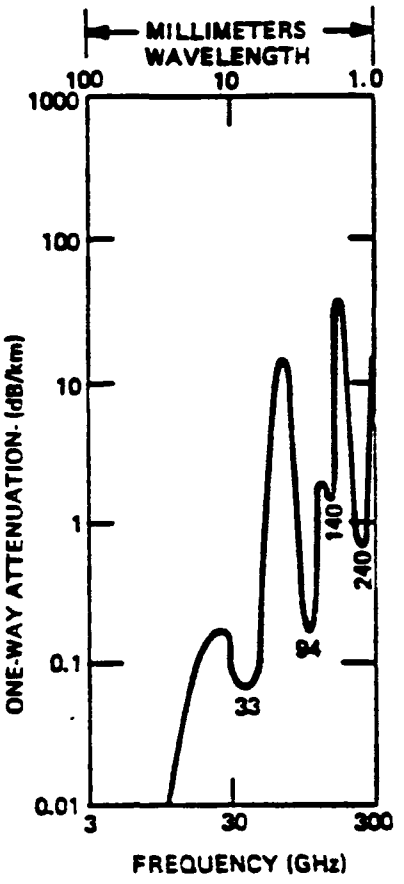



Figure 3. Prediction Chart in the Atmosphere for the Combined Effects of Oxygen and Water Vapor at Sea Level (Reprinted from Reference 2, page 33.)

The diameters of the obscurants used by the Army range from 1 to 40 microns. It can be shown by analysis that a transmitter which radiates in the 1 to 15 millimeter range will experience little attenuation. For the case of a 40 micron size particle and for 1 millimeter radiation, the size of the particle compared with the wavelength is small; the scattering process is thus characterized as Rayleigh scattering.

## IV. INITIAL CONCEPTS TO MEET OBSCURANT PAIRING REQUIREMENTS

### A. JPL Thermal Engagement Pairing System

The Thermal Engagement Pairing System (TEPS) concept, which proposed to pair with the performance of thermal sights, was considered by JPL in 1982. The main motivation behind TEPS was to present a new approach for pairing through dust, smoke, foliage and camouflage using thermal sight common modules. TEPS would use radiation in the 8 to 10 micron range from a beacon mounted on the target. The beacon radiation would be omni-

directional and modulated to carry the identification of the target vehicle. The thermal sight receiver common module would be modified to receive this data but not make it visible to the gunner. If the simulated weapon was fired when its field of view was such that it received the coded message from the target infrared (IR) beacon, a low power radio frequency (RF) message including the target ID would be broadcast. The RF coded message from the weapon would be detected at the target and transferred to the MILES or other instrumentation on the target platform to determine casualty assessment.

Several problems associated with this approach were not solved in the preliminary study. Some of the major challenges are how to separate the coded beacon radiation beam from the forward-looking IR (FLIR) image and how to make the target detectable by instrumentation without making the target more easily detectable by the FLIR operator.

B. Swartz Electro-Optics IR-TOPS

The Schwartz Electro-Optics Company (SEO) of Orlando, Florida, undertook a program to develop a pairing system using a carbon dioxide laser at 10.6 microns and an uncooled pyroelectric detector. This was part of the Army Training and Doctrine Command (TRADOC) Obscuration Pairing System (TOPS) program.

1. Laser. Some reasons for selection of the carbon dioxide laser by SEO were: expected superior performance in obscuration conditions, reliability, maturity, cost, and long shelf and operating life. However, in constructing a prototype system, SEO discovered that the lasers had a shelf life much shorter than expected. The reduced shelf life was believed to be attributable to helium leaking out of, and atmospheric water vapor leaking into, the laser cavity. In addition, SEO believed that the laser cavity was not free of contaminants prior to being filled with helium and sealed. The contaminants, which were generated internally in the laser cavity, caused further degradation of the laser. The contaminants were the results of electrode sputtering and chemical reaction of the carbon dioxide with the electrodes. Better design and manufacturing procedures and the use of RF-laser excitation could produce improvement in the laser performance and its shelf life.

2. Detector. The pyroelectric detector was chosen by SEO for the target detector because of several desirable features: uniform response over a wide range of wavelengths and the dependence on rate of change of detector temperature rather than on the value of the temperature itself. The latter attribute of the pyroelectric detector allows it to operate with much faster response time than other broadband detectors such as thermocouples. It should be noted that the detectivities of the most sensitive pyroelectrics are usually less than those detectors which operate over a much shorter spectral range.

3. Test Results. The SEO IR-TOPS program to develop a pairing system, using a carbon dioxide laser radiating at 10.6 microns and an uncooled pyroelectric detector, did not achieve the results expected. The program did not succeed in obtaining a laser with acceptable pulse rise time and stability. However, SEO management is convinced that the greatest problem is attributable to the poor performance of the pyroelectric detector. The noise equivalent power (NEP) of the tested detectors was found to be 100% higher than the vendors specifications. (NEP is the radiant flux necessary to give an output signal equal to the detector noise for a given modulation, frequency, wavelength and effective bandwidth.) In addition, SEO was unable to develop a means to overcome the microphonics associated with all pyroelectrics due to their piezoelectric nature. A plan to mount two opposing pyroelectric elements, with radiation blocked from one to reduce the microphonics, was not implemented because it was determined that the NEP would be increased by a factor of 2. Increasing the NEP of a detector would decrease the detector's D*. The D* of an infrared detector is a convenient parameter for comparing the performance of detectors and is inversely proportional to NEP. D* is proportional to the product of the square root of the area of the active element and the bandwidth.

C. Harry Diamond Laboratory MW-TOPS

The Harry Diamond Laboratory (HDL) undertook an effort to develop a pairing system using millimeter wave technology. HDL assumed that all candidate systems below 94 GHz would be unacceptable because of the multipath effect. The following systems were considered:

1. 94 GHz Pulse
2. 94 GHz CW/Frequency Discriminator
3. 94 GHz CW/Phase Locked Loop

Of the three candidates, HDL selected the Pulse System because analysis showed this system would have the longest range and least risk to develop. The CW/Frequency Discriminator system was not considered because of a predicted short operating range. Furthermore, the system would require state-of-the-art sources, multipliers and amplifiers which were determined to be expensive and technologically risky. The range performance of the CW/Phase Locked Loop System was predicted to be inferior to that of the Pulse System. Although the system was priced commensurate to that of the Pulse System, it involved a greater development risk and was thus ruled out.

Functionally, the 94 GHz pairing system was successful. The system has a narrow beam with good accuracy. The beam experienced little atmospheric attenuation and its range was verified up to a distance of 4 Km. The major objections to this system are its weight, packaging, and cost.

### D. CDEC K-TOPS

A K-band TOPS (K-TOPS) radio frequency system operating at 24 GHz was developed by the U.S. Army Combat Developments Experimentation Center (CDEC). The K-TOPS system explores using low cost RF components from police radar and radar detectors to produce an acceptable pairing system. A breadboard K-band system has been built by the Sierra Nevada Corporation of King City, California, and is currently being tested at the CDEC range at Fort Hunter-Liggett. CDEC is planning to buy several K-TOPS systems for evaluation. Further discussion and evaluation of this concept is contained in Section V.

## V. CURRENT CONCEPTS

### A. Swartz Electro-Optics IR-TOPS

This Swartz Electro-Optics (SEO) proposed concept combines the use of a 10.6 micron carbon dioxide laser transmitter on the weapon platform with four HgCdTe detector elements mounted within a single thermoelectrically (TE) cooled module on the target. The six-stage TE cooled unit is reported to be capable of reaching a temperature of 200° K. The predicted range of this system in obscurants using the TE cooled HgCdTe detector would be greater than 4 km for a laser with 20 watts output. One of the critical features of this system is the proposed hemispherical germanium dome optical system which would provide a field of view of 360 degrees in azimuth and -15 to +45 degrees in elevation.

### B. Loral Electro-Optical Systems IR-TOPS

A breadboard IR-TOPS system similar to the SEO system has been built by Loral Electro-Optical Systems (EOS) of Pasadena, California. This system also uses a 10.6 micron carbon dioxide laser transmitter. However, the target detector system uses a single TE cooled HgCdTe detector and a conical mirror optical system to give the required field of view.

### C. Sierra Nevada Corporation K-TOPS

A K-TOPS system proposed by Sierra Nevada Corporation (SNC) uses a 24 GHz K-band radio frequency transmitter with a scanning antenna to give a small effective beam width for pairing and data transmission. The target uses eight K-band receivers to give the required field of view. A description by SNC of the beam scanning used by the system is as follows: a short pulse of RF energy is transmitted via the antenna as it rotates through the 0, 90, 180, and 270 degree positions. The power level of the signal is accurately measured at the target receiver for each of the transmitter beam positions. The difference in power level between the 0 and 180 degree positions is proportional to elevation offset angle, while the difference in power level between the 90 and 270 positions is proportional to azimuth offset angle. A simple coordinate transformation algorithm in the receiver results in offset angle measurement in polar coordinates (magnitude and direction).

### D. Loral EOS K-TOPS

Loral EOS has also proposed a K-TOPS system operating at 24 GHz. The Loral EOS system would have three fixed and overlapping K-band transmitters on the weapon platform and a network of K-band receivers at the target.

### E. Hybrid System

A possible solution to the limitations of laser and RF technologies would be a system that uses the best features of each, a concept that has been given limited study. Such a hybrid system was discussed at a meeting between JPL and Synrad, Inc., of Seattle, Washington, as part of this current effort. At trigger pull, the system would transmit a single pulse from a 10.6 micron carbon dioxide laser in combination with an RF broadcast of pairing data. The narrow beam laser pulse would be used only to establish a hit. A directional RF message, lasting in duration between 10 to 100 microseconds, would contain the needed information to complete a pairing. Some advantages of this system include: an eyesafe laser beam which can be more easily manipulated to achieve acceptable beam geometry, a reduction of laser total output power, the use of proven mature technology, and minimization of false triggering (see Section VIII). The target detectors used in this system would be uncooled pyroelectrics and RF receivers.

## VI. OTHER CONCEPTS WORTHY OF CONSIDERATION

### A. Improved Detectors

The SEO IR-TOPS program using a 10.6 micron $CO_2$ laser/ pyroelectric detector should be reconsidered. The main failure of this approach was microphonic noise associated with the detector and lack of power and stability of the laser.

In recent years there has been significant improvement in laser technology, resulting in improved laser output stability and power. The microphonics noise associated with the pyroelectric detector, defined by SEO to be the main cause for their program failure, is not inherent to the detector. The microphonic noise is developed by piezoelectric currents in the detector which result from vibrations. It may be possible to reduce these currents with improved packaging and circuitry. A significant noise reduction and improved laser output power and stability may be enough to make this approach workable. However, when the detector is used with a short pulse laser, another noise source could result from localized heating in the pyrocrystal which would produce piezoelectric ringing.

### B. Erbium Glass Lasers

KEI Laser Inc. of Orlando, Florida has developed an erbium glass laser rangefinder for the U.S. Army. The rangefinder is reported by KEI (Reference 3) to have many features which are the same as those sought for pairing through obscurants. Some of these common features are:

1. The erbium glass laser is eyesafe for all military uses.

2. The laser represents proven and tested technology.

3. The laser is reliable and easy to maintain.

4. The 1.54 micron radiation of an erbium glass laser can be detected using room temperature detectors.

5. The erbium glass laser uses inexpensive visible glass optics.

6. The laser material is easy to fabricate.

The erbium glass range finder is also reported to have improved performance in smoke and dust (Reference 4). The extent of this performance in battlefield smoke and dust has not yet been documented. The answer might be found in the results of smoke tests conducted by the US Army PM-SMOKE in May, 1987, but as yet unreported. In Section III of this report, analytical results were presented which show that a window exists in the 1.50 to 1.77 micron interval for the combined effects of water vapor, uniform mixed gases and ozone. Smoke extinction for a fog oil smoke is shown in Figure 1 to be about 1.5 meters$^2$/gram at 1.54 microns. This is an area which should be revisited to determine with greater accuracy the extinction coefficients versus wavelength for the typical Army smokes.

If the erbium glass laser proves to be acceptable for penetrating typical battlefield obscurants, uncooled detectors should be evaluated to determine an acceptable target detector. The list of candidates includes pyroelectric, lead sulfide and germanium detectors.

C. Distributed Sensors

SEO and Loral have developed concepts for IR-TOPS which use a single TE cooled HgCdTe detector as the target for the carbon dioxide 10.6 micron laser. The target detector unit is top-mounted on the vehicle. An improvement to this system for more realistic target hit zone geometry would be to use multiple fiber-optic sensors coupled to a very sensitive detector. The output of each sensor would be multiplexed to the detector to allow the magnitude of the radiation received by each sensor to be determined. This would help in determining what part of the target was hit, from what direction the hit was made, and would provide for target defilade.

Because of its ability to penetrate some obscurants, a transmitter at 10.6 microns would be one candidate to use with this system . However, because of infrared absorption bands of fiber-optic materials such as chalcogenide glass fiber, 10.6 micron radiation would be severely attenuated (see Figure 4) (Reference 5). Due to

the high absorption loss at 10.6 microns, high power laser transmission could damage the fiber. Research efforts are ongoing to produce higher purity chalcogenide fibers to reduce the absorption loss (Reference 6). However, for short length sensors and low power laser use, the fibers currently available may be acceptable (Reference 7).

If the 1.54 micron erbium glass laser radiation is proven to have an acceptable ability to penetrate obscurants, it may be the candidate transmitter that will make a fiber-optics pairing system viable. Fluoride glass fibers transmit from the near ultraviolet range to about 5 microns in the infrared range. The lowest radiative losses occur between 1 and 4 microns. A typical loss curve for a glass-clad fiber is shown in Figure 5.

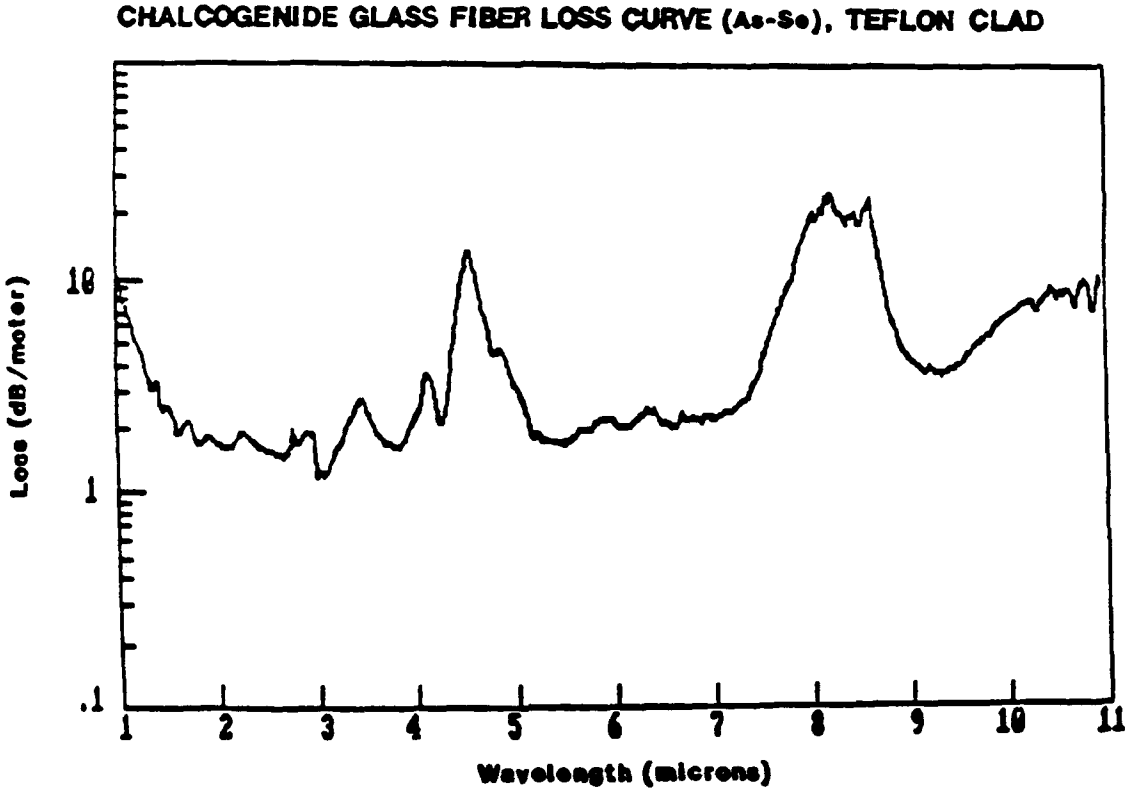



Figure 4. Chalcogenide Glass Fiber Loss Curve (As-Se), Teflon Clad (Reprinted from Reference 7, Figure 3.)

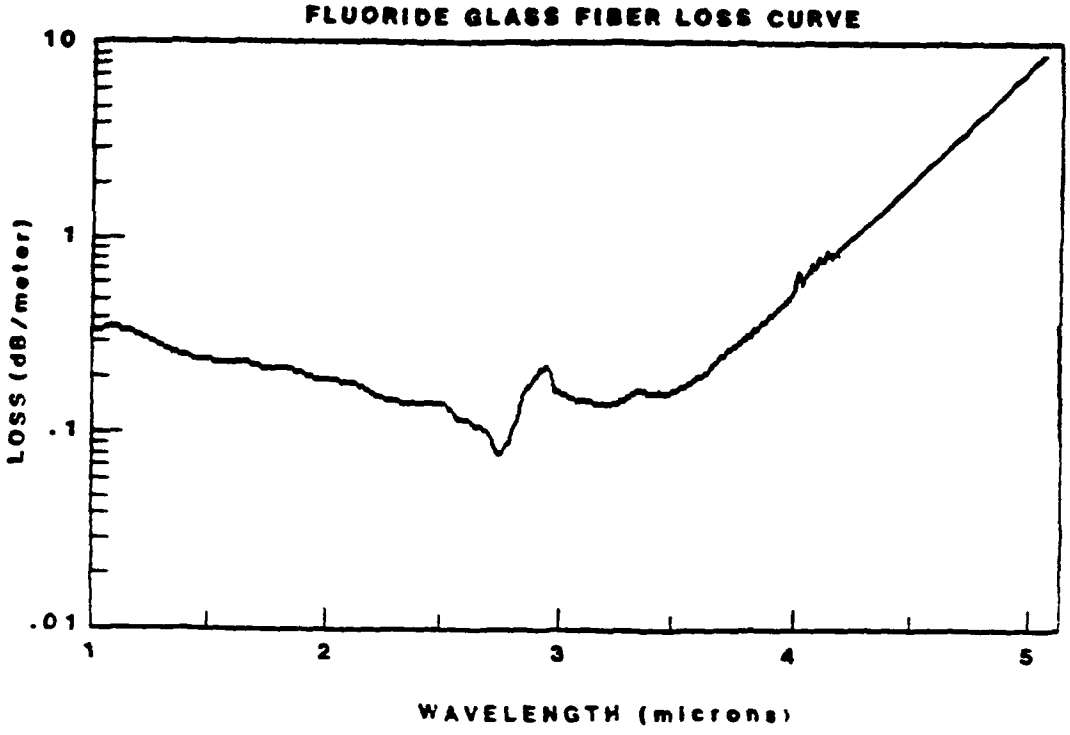



Figure 5. Fluoride Glass Fiber Loss Curve
(Reprinted from Reference 7, Figure 1.)

D. Training Smokes

The use of special training smokes that would be compatible with the MILES gallium arsenide transmitter has been considered in other studies. As part of this current study, an inquiry was made to PM-SMOKE concerning the availability of obscurants that could be used as training smokes. No acceptable smokes have been identified and none appear to be available in the immediate future (Reference 8). Moreover, because of the difficulty and expense in developing training smokes that have properties of current obscurants and at the same time meet Army safety requirements, this approach does not appear to be worthy of further consideration.

## VII. CONCEPT DEVELOPMENT

In order for one of the pairing concepts described in this report to be selected with confidence, more complete evaluations are necessary and some predevelopment experimental efforts should be initiated.

A. The SNC K-TOPS system appears to be the most advanced in terms of the state of current development. The system is reported by its developers to be capable of meeting the requirement for pairing through the ambient atmosphere

and the Army obscurants and even to improve on the performance of MILES in the absence of obscurants. However, there are additional questions which need to be addressed, including:

1. What is the solution for overcoming the relatively large beam geometry of the transmitter?

2. How does the system limit pairing range (to match weapon performance) and control beam size with range?

3. How effective and reliable is the system under dynamic field operating conditions?

B. The efforts by SEO to develop an IR-TOPS using a $CO_2$ laser and a pyroelectric detector have not been successful. However, the reasons for failure so far suggest that the concept should be reconsidered. Recent progress in the performance of $CO_2$ laser power and stability suggests that lasers are available that could possibly meet the transmitter requirements. The pyroelectric detector noise problem, which was described by SEO to be its greatest barrier to success, should be explored to determine if noise can be reduced to an acceptable level to permit a viable pairing system.

C. The IR (1.54) TOPS concept has major issues which must be addressed:

1. What is the performance of the erbium glass laser transmitter in typical battlefield obscurants?

2. Which type of detector system would permit optimum system performance?

3. Can the laser meet the transmitter power requirements?

D. The Synrad hybrid system for pairing through obscurants would use technologies that are mature; however the concept needs to be proven. Development work should include the following:

1. Analysis and tests to determine the required performance levels for the target detector and the laser transmitter.

2. Design, construction and testing of the IR/RF triggering, pairing, and data transfer systems to meet engagement time requirements.

## VIII. ASSESSMENT OF OBSCURATION TECHNOLOGIES

A comparison of the various current obscuration technologies is presented as Appendix A, Matrix Assessment of Obscuration Technologies.

## IX. RECOMMENDED PAIRING CONCEPT

Successful implementation of any one of the concepts charted in Appendix A should permit pairing beyond the present capability of MILES. However, the concept which appears to be most acceptable from the standpoint of using mature technology, and therefore reducing developmental risk, would be a hybrid system using both infrared and radio frequency technologies. This choice is made for the following primary reasons:

1. The system would utilize components from mature and proven technologies.

2. The use of a combination of the laser and the radio to achieve pairing should decrease the laser and RF performance requirements below those required for each technology when used alone.

3. The requirement for the target to receive both IR and RF signals could be used to minimize false triggering.

4. The use of inexpensive, distributed, uncooled pyroelectric detectors on vehicles would establish realistic hit zone geometry.

5. The use of the transmitter laser beam only to establish a hit should permit tailoring of the beam geometry.

# APPENDIX A

## MATRIX ASSESSMENT OF OBSCURATION TECHNOLOGIES

| SYSTEM | SYSTEM CONCEPT | ADVANTAGES | DISADVANTAGES |
|---|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | System uses10.6 micron CO2 laser transmitter to simulate weapon firing. Target uses four thermo-electrically cooled HgCdTe detectors mounted on top of the vehicle to give 360 degree coverage | Good obscurant penetration through smoke. Small, controllable beam diameter. | Relatively expensive and complex cooled detectors (especially for multiple detectors). Possible problems achieving adequate range through dust. Single, top-mounted detector location is undesirable (cannot play defilade, unrealistic aiming). |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | System uses a 24 GHz K-band transmitter with a scanning antenna to give a relatively small effective beam width. Target uses eight K-band receivers to give 360 degree coverage | Penetrates most obscurants. Large near-miss window; might allow simulation of lead. Nearly unlimited line-of-sight pairing range. High pairing reliability in any atmosphere. Brassboard system is in operation. Should be a low cost approach. | Relatively large effective beam diameter. Difficult to control maximum range. System cannot fit completely inside gun tube. |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | System uses 10.6 micron CO2 laser transmitter. Target is a single thermo-electrically cooled HgCdTe detector mounted on top of the vehicle with a conical mirror to give 360 degree coverage | Good obscurant penetration through smoke. Small, controllable beam diameter. Brassboard hardware has been built and tested. | Relatively expensive and complex cooled detectors (especially for multiple detectors). Possible problems achieving adequate range through dust. Single, top-mounted detector location is undesirable (cannot play defilade, unrealistic aiming). |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | System uses three overlapping K-band transmitters with a network of K-band receivers at the target | Can penetrate most obscurants. Can easily accommodate pairing data. Nearly unlimited line-of-sight pairing range. | Multiple transmitter concept has not been demonstrated. Effective beam diameter unknown. Difficult to control maximum range. |
| Synrad, Inc.<br>Bothell, Washington | System uses high power CO2 laser to transmit a single pulse for pairing. The target would use single or multiple uncooled pyroelectric detectors. A wide-beam RF (24 GHz) transmitter and receiver would then be used to transmit pairing data. | Uncooled detector relatively inexpensive; possibly adaptable to belt-type systems. Laser transmission is single, high-energy pairing pulse. Good obscurant penetration. Requirement to receive both IR and RF message could minimize false triggering. | Unproven detector capability in operating environment. Requires separate RF system to transmit pairing data. Concept has not been demonstrated. |
| IR (1.54 Micron) TOPS | System uses a 1.54 micron erbium glass laser transmitter. A choice of either lead sulfide or germanium uncooled detectors could be acceptable as target receiver. | Technology proven in existing eyesafe rangefinder. Can penetrate smoke. Uses inexpensive visual optics and uncooled detectors which can be distributed for realistic target geometry. Small, controllable beam diameter. | Obscurant penetration of erbium glass laser radiation may not equal performance of that of 10.6 micron CO2 laser. |

Matrix Assessment of Obscuration Technologies
(continued)

| SYSTEM | MATURITY OF TECHNOLOGY | SAFETY | ABILITY TO PAIR THROUGH OBSCURANTS | REALISM |
|---|---|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | Components are from mature technology. Several vendors should be able to supply acceptable laser and detectors. | Eye safe. The CO2 laser transmitter energy density can be controlled so as to cause no personnel safety problems. | System uses10.6 micron CO2 laser which can penetrate natural obscurants, fog oil smoke, and limited dust. | History indicates that detectors mounted in a single location on top of tank result in unrealistic aiming. Like MILES,system cannot be used with fire control computer. |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | Components are from highly developed current technology which provide commercial components for police radar and radar detectors. | Safe. Transmitter uses 24 GHz frequency, a frequency commonly used for radar traffic controllers, which has posed no known safety problems for personnel. | The 24 GHz RF transmission can penetrate natural obscurants, fog oil smoke, and some dust | System could use corner detectors for greater realism. Wide hit window might allow use of fire control computer |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Components are from mature technology. Several vendors should be able to supply acceptable laser and detectors. | Eye safe. The CO2 laser transmitter energy density can be controlled so as to cause no personnel safety problems. | System uses 10 6 micron CO2 laser which can penetrate natural obscurants, fog oil smoke, and limited dust. | History indicates that detectors mounted in a single location on top of tank result in unrealistic aiming. Like MILES, system cannot be used with fire control computer. |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Components are from highly developed current technology which provide commercial components for police radar and radar detectors. | Safe. The system uses three 24 GHz transmitters. See Sierra Nevada's K-TOPS above. | The 24 GHz RF transmission can penetrate natural obscurants, fog oil smoke, and some dust. | System could use corner detectors for greater realism. Wide hit window might allow use of fire control computer. |
| Synrad, Inc.<br>Bothell, Washington | Components are from mature technology. Some development efforts for detector circuit may be necessary. | Laser transmitter should be capable of operating within eye safe limits. | System uses10.6 micron CO2 laser which can penetrate fog oil smoke and some dust. | Possibility of using multiple detectors, as with MILES, would permit more realistic gunnery. Like MILES, system cannot be used with fire control computer. |
| IR (1.54 Micron) TOPS | Erbium glass laser transmitter and the choice of either lead sulfide or germanium detectors represent mature technologies. | System would be eyesafe; the transmitter is currently being used in an eyesafe military rangefinder system. | Laser transmitter is reported to have good obscurant penetration (see note 1 in Comments). | |

## Matrix Assessment of Obscuration Technologies
(continued)

| SYSTEM | MILES COMPATIBILITY | OPERATING RANGE | ANGULAR COVERAGE | PAIRING DATA |
|---|---|---|---|---|
| **IR-TOPS**<br>**Schwartz Electro-Optics**<br>**Orlando, Florida** | The system would complement MILES and can be designed to interface with MILES. | Range will depend on laser energy and coded messages. 3 4 km is probable | The system would have a field of view of 360 degrees in azimuth and 15 to +45 degrees in elevation. | Should be able to transmit adequate pairing data if a laser of sufficient power is used. |
| **K-TOPS**<br>**Sierra Nevada Corporation**<br>**King City, California** | The system would complement MILES and can be designed to interface with MILES. | Reported to have ranging capability from 50 m to 5 km | Coverage is accomplished by four separate RF receiver pairs, each of which provides coverage over a sector of 90 degrees in azimuth and 45 degrees in elevation | Prototype can identify 1024 players, 16 weapon/munition possibilities. |
| **IR-TOPS**<br>**Loral Electro-Optical Systems**<br>**Pasadena, California** | The system would complement MILES and can be designed to interface with MILES. | Expected to be up to 5.5 Km in fog oil smoke based on extrapolation of shorter range test data. | The system would have a field of view coverage of 360 degrees in azimuth and -15 to +45 degrees in elevation. | MILES-type pairing data plus player ID has been developed. |
| **K-TOPS**<br>**Loral Electro-Optical Systems**<br>**Pasadena, California** | The system would complement MILES and can be designed to interface with MILES. | Should be comparable to Sierra Nevada K-TOPS. | The system would have a field-of-view of 360 degrees in azimuth and -15 to +45 degrees in elevation. | Has not been determined but should be acceptable. |
| **Synrad, Inc.**<br>**Bothell, Washington** | The system would complement MILES and can be designed to interface with MILES. | Range should exceed 3 km since high power CO2 laser is used only to establish pairing between weapon and target. | Proposed concept should meet Army requirements but has not yet been determined. | Would be transmitted by RF. Has not yet been determined but should be acceptable. |
| **IR (1.54 Micron) TOPS** | The system would complement MILES and can be designed to interface with MILES. | Not yet determined, but appears acceptable. | Concept should meet Army requirements but has not yet been determined. | Not yet determined, but should be acceptable. |

## Matrix Assessment of Obscuration Technologies
(continued)

| SYSTEM | PAIRING DURATION | MULTIPLE PAIRING | POWER REQUIREMENTS | AVAILABILITY |
|---|---|---|---|---|
| IR-TOPS<br>Schwanz Electro-Optics<br>Orlando, Florida | Should be acceptable, but will be a design driver | Small beam width should preclude multiple pairing | Would be compatible with combat vehicle power supply | The basic components for this system are readily available. There may be a need for some development work for the detector window configuration to provide wide field of view |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | 250 milliseconds, about the allowable maximum. | Could be a problem due to relatively large expected beam diameter. | Would be compatible with combat vehicle power supply | The period of construction should be about two years. Prototype systems should be available by the end of CY 1999. |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Should be acceptable, but will be a design driver. | Small beam diameter should preclude multiple pairing | Would be compatible with combat vehicle power supply. | Prototypes could be available in nine months. |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | RF transmission of pairing data results in very short processing time. | Could be a problem due to relatively large expected beam diameter. | Would be compatible with combat vehicle power supply. | Unknown. |
| Synrad, Inc.<br>Bothell, Washington | RF transmission of pairing data results in very short processing time (less than 10 milliseconds). | Small laser beam diameter should preclude multiple pairing. RF transmitter does not have to be narrow beam. | Would be compatible with combat vehicle power supply. | Should be possible to construct system within two years. Some developmental testing of laser ranging and beam divergence may be necessary. |
| IR (1.54 Micron) TOPS | | Not yet determined, but should be acceptable | Would be compatible with combat vehicle power supply. | Could be prototyped within two years. Some developmental testing to define laser range compatibility, beam geometry, and detector performance needs to be completed. |

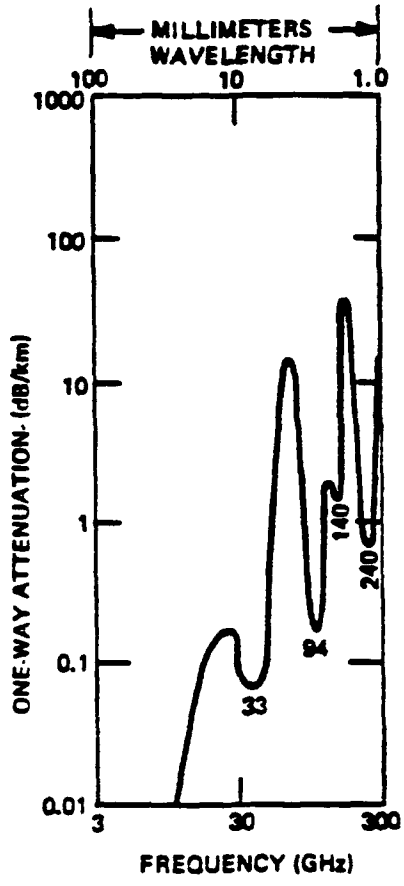



Figure 3. Prediction Chart in the Atmosphere for the Combined Effects of Oxygen and Water Vapor at Sea Level (Reprinted from Reference 2, page 33.)

The diameters of the obscurants used by the Army range from 1 to 40 microns. It can be shown by analysis that a transmitter which radiates in the 1 to 15 millimeter range will experience little attenuation. For the case of a 40 micron size particle and for 1 millimeter radiation, the size of the particle compared with the wavelength is small; the scattering process is thus characterized as Rayleigh scattering.

## IV. INITIAL CONCEPTS TO MEET OBSCURANT PAIRING REQUIREMENTS

### A. JPL Thermal Engagement Pairing System

The Thermal Engagement Pairing System (TEPS) concept, which proposed to pair with the performance of thermal sights, was considered by JPL in 1982. The main motivation behind TEPS was to present a new approach for pairing through dust, smoke, foliage and camouflage using thermal sight common modules. TEPS would use radiation in the 8 to 10 micron range from a beacon mounted on the target. The beacon radiation would be omni-

directional and modulated to carry the identification of the target vehicle. The thermal sight receiver common module would be modified to receive this data but not make it visible to the gunner. If the simulated weapon was fired when its field of view was such that it received the coded message from the target infrared (IR) beacon, a low power radio frequency (RF) message including the target ID would be broadcast. The RF coded message from the weapon would be detected at the target and transferred to the MILES or other instrumentation on the target platform to determine casualty assessment.

Several problems associated with this approach were not solved in the preliminary study. Some of the major challenges are how to separate the coded beacon radiation beam from the forward-looking IR (FLIR) image and how to make the target detectable by instrumentation without making the target more easily detectable by the FLIR operator.

B. Swartz Electro-Optics IR-TOPS

The Schwartz Electro-Optics Company (SEO) of Orlando, Florida, undertook a program to develop a pairing system using a carbon dioxide laser at 10.6 microns and an uncooled pyroelectric detector. This was part of the Army Training and Doctrine Command (TRADOC) Obscuration Pairing System (TOPS) program.

1. Laser. Some reasons for selection of the carbon dioxide laser by SEO were: expected superior performance in obscuration conditions, reliability, maturity, cost, and long shelf and operating life. However, in constructing a prototype system, SEO discovered that the lasers had a shelf life much shorter than expected. The reduced shelf life was believed to be attributable to helium leaking out of, and atmospheric water vapor leaking into, the laser cavity. In addition, SEO believed that the laser cavity was not free of contaminants prior to being filled with helium and sealed. The contaminants, which were generated internally in the laser cavity, caused further degradation of the laser. The contaminants were the results of electrode sputtering and chemical reaction of the carbon dioxide with the electrodes. Better design and manufacturing procedures and the use of RF-laser excitation could produce improvement in the laser performance and its shelf life.

2. Detector. The pyroelectric detector was chosen by SEO for the target detector because of several desirable features: uniform response over a wide range of wavelengths and the dependence on rate of change of detector temperature rather than on the value of the temperature itself. The latter attribute of the pyroelectric detector allows it to operate with much faster response time than other broadband detectors such as thermocouples. It should be noted that the detectivities of the most sensitive pyroelectrics are usually less than those detectors which operate over a much shorter spectral range.

3. Test Results. The SEO IR-TOPS program to develop a pairing system, using a carbon dioxide laser radiating at 10.6 microns and an uncooled pyroelectric detector, did not achieve the results expected. The program did not succeed in obtaining a laser with acceptable pulse rise time and stability. However, SEO management is convinced that the greatest problem is attributable to the poor performance of the pyroelectric detector. The noise equivalent power (NEP) of the tested detectors was found to be 100% higher than the vendors specifications. (NEP is the radiant flux necessary to give an output signal equal to the detector noise for a given modulation, frequency, wavelength and effective bandwidth.) In addition, SEO was unable to develop a means to overcome the microphonics associated with all pyroelectrics due to their piezoelectric nature. A plan to mount two opposing pyroelectric elements, with radiation blocked from one to reduce the microphonics, was not implemented because it was determined that the NEP would be increased by a factor of 2. Increasing the NEP of a detector would decrease the detector's D*. The D* of an infrared detector is a convenient parameter for comparing the performance of detectors and is inversely proportional to NEP. D* is proportional to the product of the square root of the area of the active element and the bandwidth.

C. Harry Diamond Laboratory MW-TOPS

The Harry Diamond Laboratory (HDL) undertook an effort to develop a pairing system using millimeter wave technology. HDL assumed that all candidate systems below 94 GHz would be unacceptable because of the multipath effect. The following systems were considered:

1. 94 GHz Pulse
2. 94 GHz CW/Frequency Discriminator
3. 94 GHz CW/Phase Locked Loop

Of the three candidates, HDL selected the Pulse System because analysis showed this system would have the longest range and least risk to develop. The CW/Frequency Discriminator system was not considered because of a predicted short operating range. Furthermore, the system would require state-of-the-art sources, multipliers and amplifiers which were determined to be expensive and technologically risky. The range performance of the CW/Phase Locked Loop System was predicted to be inferior to that of the Pulse System. Although the system was priced commensurate to that of the Pulse System, it involved a greater development risk and was thus ruled out.

Functionally, the 94 GHz pairing system was successful. The system has a narrow beam with good accuracy. The beam experienced little atmospheric attenuation and its range was verified up to a distance of 4 Km. The major objections to this system are its weight, packaging, and cost.

### D. CDEC K-TOPS

A K-band TOPS (K-TOPS) radio frequency system operating at 24 GHz was developed by the U.S. Army Combat Developments Experimentation Center (CDEC). The K-TOPS system explores using low cost RF components from police radar and radar detectors to produce an acceptable pairing system. A breadboard K-band system has been built by the Sierra Nevada Corporation of King City, California, and is currently being tested at the CDEC range at Fort Hunter-Liggett. CDEC is planning to buy several K-TOPS systems for evaluation. Further discussion and evaluation of this concept is contained in Section V.

## V. CURRENT CONCEPTS

### A. Swartz Electro-Optics IR-TOPS

This Swartz Electro-Optics (SEO) proposed concept combines the use of a 10.6 micron carbon dioxide laser transmitter on the weapon platform with four HgCdTe detector elements mounted within a single thermoelectrically (TE) cooled module on the target. The six-stage TE cooled unit is reported to be capable of reaching a temperature of 200° K. The predicted range of this system in obscurants using the TE cooled HgCdTe detector would be greater than 4 km for a laser with 20 watts output. One of the critical features of this system is the proposed hemispherical germanium dome optical system which would provide a field of view of 360 degrees in azimuth and -15 to +45 degrees in elevation.

### B. Loral Electro-Optical Systems IR-TOPS

A breadboard IR-TOPS system similar to the SEO system has been built by Loral Electro-Optical Systems (EOS) of Pasadena, California. This system also uses a 10.6 micron carbon dioxide laser transmitter. However, the target detector system uses a single TE cooled HgCdTe detector and a conical mirror optical system to give the required field of view.

### C. Sierra Nevada Corporation K-TOPS

A K-TOPS system proposed by Sierra Nevada Corporation (SNC) uses a 24 GHz K-band radio frequency transmitter with a scanning antenna to give a small effective beam width for pairing and data transmission. The target uses eight K-band receivers to give the required field of view. A description by SNC of the beam scanning used by the system is as follows: a short pulse of RF energy is transmitted via the antenna as it rotates through the 0, 90, 180, and 270 degree positions. The power level of the signal is accurately measured at the target receiver for each of the transmitter beam positions. The difference in power level between the 0 and 180 degree positions is proportional to elevation offset angle, while the difference in power level between the 90 and 270 positions is proportional to azimuth offset angle. A simple coordinate transformation algorithm in the receiver results in offset angle measurement in polar coordinates (magnitude and direction).

### D. Loral EOS K-TOPS

Loral EOS has also proposed a K-TOPS system operating at 24 GHz. The Loral EOS system would have three fixed and overlapping K-band transmitters on the weapon platform and a network of K-band receivers at the target.

### E. Hybrid System

A possible solution to the limitations of laser and RF technologies would be a system that uses the best features of each, a concept that has been given limited study. Such a hybrid system was discussed at a meeting between JPL and Synrad, Inc., of Seattle, Washington, as part of this current effort. At trigger pull, the system would transmit a single pulse from a 10.6 micron carbon dioxide laser in combination with an RF broadcast of pairing data. The narrow beam laser pulse would be used only to establish a hit. A directional RF message, lasting in duration between 10 to 100 microseconds, would contain the needed information to complete a pairing. Some advantages of this system include: an eyesafe laser beam which can be more easily manipulated to achieve acceptable beam geometry, a reduction of laser total output power, the use of proven mature technology, and minimization of false triggering (see Section VIII). The target detectors used in this system would be uncooled pyroelectrics and RF receivers.

## VI. OTHER CONCEPTS WORTHY OF CONSIDERATION

### A. Improved Detectors

The SEO IR-TOPS program using a 10.6 micron $CO_2$ laser/ pyroelectric detector should be reconsidered. The main failure of this approach was microphonic noise associated with the detector and lack of power and stability of the laser.

In recent years there has been significant improvement in laser technology, resulting in improved laser output stability and power. The microphonics noise associated with the pyroelectric detector, defined by SEO to be the main cause for their program failure, is not inherent to the detector. The microphonic noise is developed by piezoelectric currents in the detector which result from vibrations. It may be possible to reduce these currents with improved packaging and circuitry. A significant noise reduction and improved laser output power and stability may be enough to make this approach workable. However, when the detector is used with a short pulse laser, another noise source could result from localized heating in the pyrocrystal which would produce piezoelectric ringing.

### B. Erbium Glass Lasers

KEI Laser Inc. of Orlando, Florida has developed an erbium glass laser rangefinder for the U.S. Army. The rangefinder is reported by KEI (Reference 3) to have many features which are the same as those sought for pairing through obscurants. Some of these common features are:

1. The erbium glass laser is eyesafe for all military uses.

2. The laser represents proven and tested technology.

3. The laser is reliable and easy to maintain.

4. The 1.54 micron radiation of an erbium glass laser can be detected using room temperature detectors.

5. The erbium glass laser uses inexpensive visible glass optics.

6. The laser material is easy to fabricate.

The erbium glass range finder is also reported to have improved performance in smoke and dust (Reference 4). The extent of this performance in battlefield smoke and dust has not yet been documented. The answer might be found in the results of smoke tests conducted by the US Army PM-SMOKE in May, 1987, but as yet unreported. In Section III of this report, analytical results were presented which show that a window exists in the 1.50 to 1.77 micron interval for the combined effects of water vapor, uniform mixed gases and ozone. Smoke extinction for a fog oil smoke is shown in Figure 1 to be about 1.5 meters$^2$/gram at 1.54 microns. This is an area which should be revisited to determine with greater accuracy the extinction coefficients versus wavelength for the typical Army smokes.

If the erbium glass laser proves to be acceptable for penetrating typical battlefield obscurants, uncooled detectors should be evaluated to determine an acceptable target detector. The list of candidates includes pyroelectric, lead sulfide and germanium detectors.

C. Distributed Sensors

SEO and Loral have developed concepts for IR-TOPS which use a single TE cooled HgCdTe detector as the target for the carbon dioxide 10.6 micron laser. The target detector unit is top-mounted on the vehicle. An improvement to this system for more realistic target hit zone geometry would be to use multiple fiber-optic sensors coupled to a very sensitive detector. The output of each sensor would be multiplexed to the detector to allow the magnitude of the radiation received by each sensor to be determined. This would help in determining what part of the target was hit, from what direction the hit was made, and would provide for target defilade.

Because of its ability to penetrate some obscurants, a transmitter at 10.6 microns would be one candidate to use with this system. However, because of infrared absorption bands of fiber-optic materials such as chalcogenide glass fiber, 10.6 micron radiation would be severely attenuated (see Figure 4) (Reference 5). Due to

the high absorption loss at 10.6 microns, high power laser transmission could damage the fiber. Research efforts are ongoing to produce higher purity chalcogenide fibers to reduce the absorption loss (Reference 6). However, for short length sensors and low power laser use, the fibers currently available may be acceptable (Reference 7).

If the 1.54 micron erbium glass laser radiation is proven to have an acceptable ability to penetrate obscurants, it may be the candidate transmitter that will make a fiber-optics pairing system viable. Fluoride glass fibers transmit from the near ultraviolet range to about 5 microns in the infrared range. The lowest radiative losses occur between 1 and 4 microns. A typical loss curve for a glass-clad fiber is shown in Figure 5.

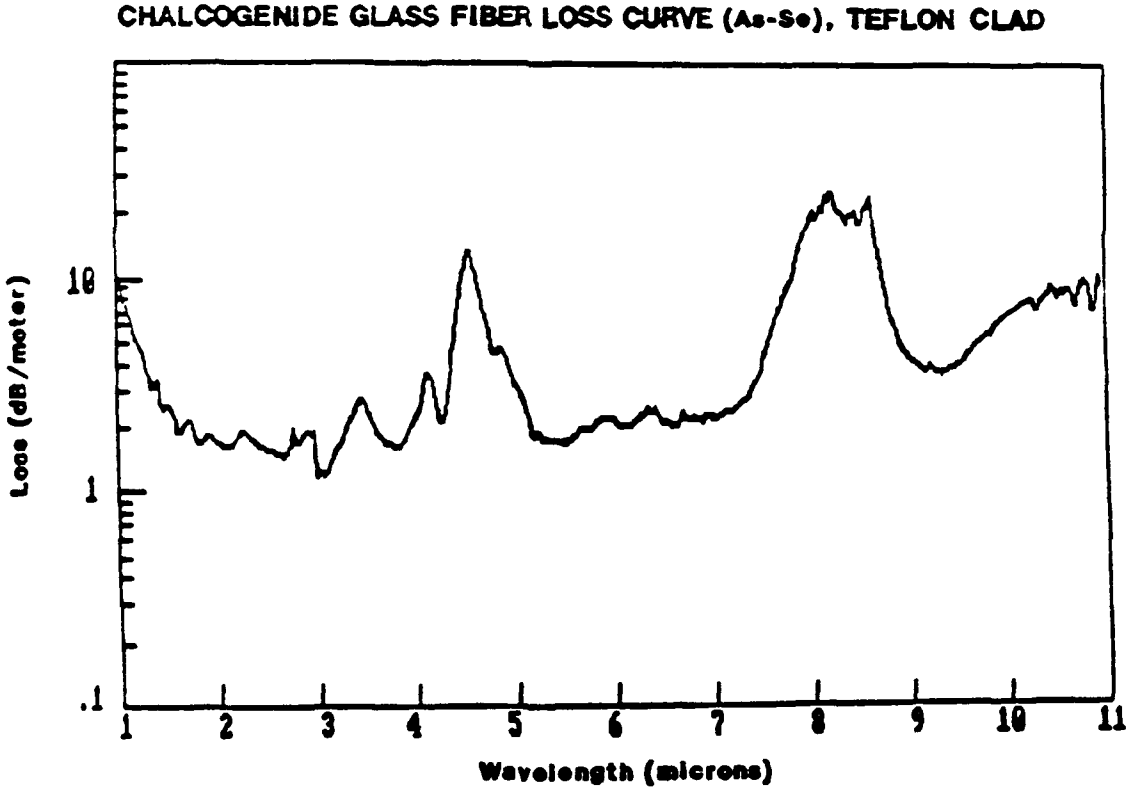



Figure 4. Chalcogenide Glass Fiber Loss Curve (As-Se), Teflon Clad (Reprinted from Reference 7, Figure 3.)

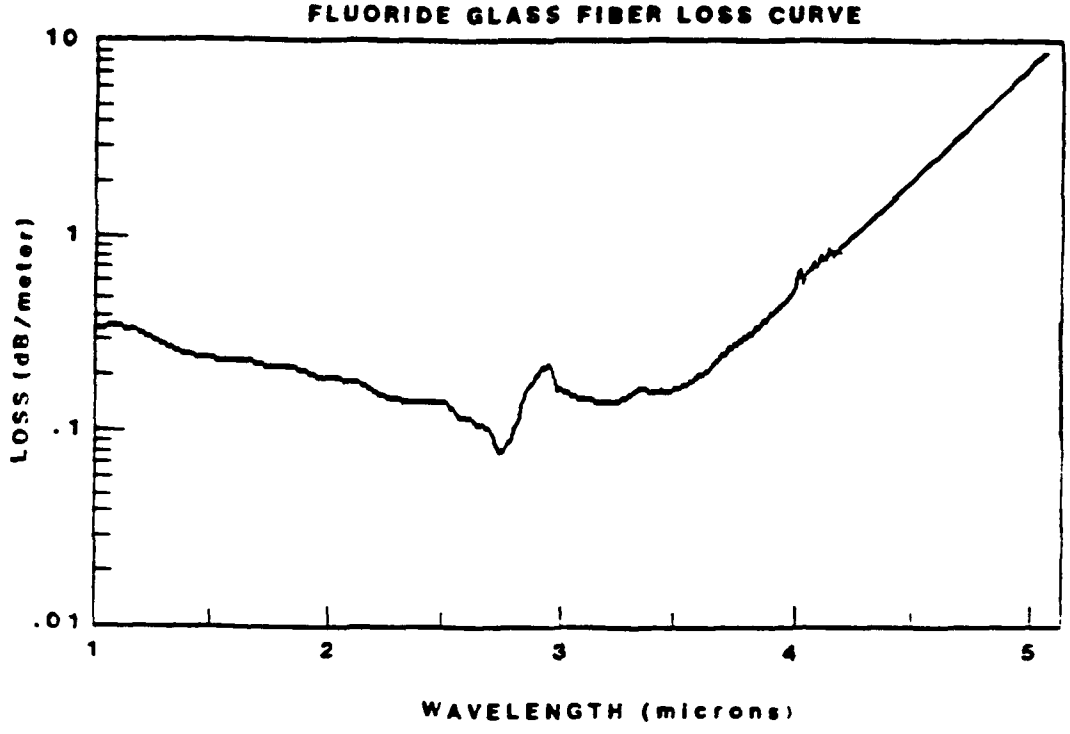



Figure 5. Fluoride Glass Fiber Loss Curve
(Reprinted from Reference 7, Figure 1.)

D. Training Smokes

The use of special training smokes that would be compatible with the MILES gallium arsenide transmitter has been considered in other studies. As part of this current study, an inquiry was made to PM-SMOKE concerning the availability of obscurants that could be used as training smokes. No acceptable smokes have been identified and none appear to be available in the immediate future (Reference 8). Moreover, because of the difficulty and expense in developing training smokes that have properties of current obscurants and at the same time meet Army safety requirements, this approach does not appear to be worthy of further consideration.

## VII. CONCEPT DEVELOPMENT

In order for one of the pairing concepts described in this report to be selected with confidence, more complete evaluations are necessary and some predevelopment experimental efforts should be initiated.

A. The SNC K-TOPS system appears to be the most advanced in terms of the state of current development. The system is reported by its developers to be capable of meeting the requirement for pairing through the ambient atmosphere

and the Army obscurants and even to improve on the performance of MILES in the absence of obscurants. However, there are additional questions which need to be addressed, including:

1. What is the solution for overcoming the relatively large beam geometry of the transmitter?

2. How does the system limit pairing range (to match weapon performance) and control beam size with range?

3. How effective and reliable is the system under dynamic field operating conditions?

B. The efforts by SEO to develop an IR-TOPS using a $CO_2$ laser and a pyroelectric detector have not been successful. However, the reasons for failure so far suggest that the concept should be reconsidered. Recent progress in the performance of $CO_2$ laser power and stability suggests that lasers are available that could possibly meet the transmitter requirements. The pyroelectric detector noise problem, which was described by SEO to be its greatest barrier to success, should be explored to determine if noise can be reduced to an acceptable level to permit a viable pairing system.

C. The IR (1.54) TOPS concept has major issues which must be addressed:

1. What is the performance of the erbium glass laser transmitter in typical battlefield obscurants?

2. Which type of detector system would permit optimum system performance?

3. Can the laser meet the transmitter power requirements?

D. The Synrad hybrid system for pairing through obscurants would use technologies that are mature; however the concept needs to be proven. Development work should include the following:

1. Analysis and tests to determine the required performance levels for the target detector and the laser transmitter.

2. Design, construction and testing of the IR/RF triggering, pairing, and data transfer systems to meet engagement time requirements.

## VIII. ASSESSMENT OF OBSCURATION TECHNOLOGIES

A comparison of the various current obscuration technologies is presented as Appendix A, Matrix Assessment of Obscuration Technologies.

## IX. RECOMMENDED PAIRING CONCEPT

Successful implementation of any one of the concepts charted in Appendix A should permit pairing beyond the present capability of MILES. However, the concept which appears to be most acceptable from the standpoint of using mature technology, and therefore reducing developmental risk, would be a hybrid system using both infrared and radio frequency technologies. This choice is made for the following primary reasons:

1. The system would utilize components from mature and proven technologies.

2. The use of a combination of the laser and the radio to achieve pairing should decrease the laser and RF performance requirements below those required for each technology when used alone.

3. The requirement for the target to receive both IR and RF signals could be used to minimize false triggering.

4. The use of inexpensive, distributed, uncooled pyroelectric detectors on vehicles would establish realistic hit zone geometry.

5. The use of the transmitter laser beam only to establish a hit should permit tailoring of the beam geometry.

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| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | System uses a 24 GHz K-band transmitter with a scanning antenna to give a relatively small effective beam width. Target uses eight K-band receivers to give 360 degree coverage | Penetrates most obscurants. Large near-miss window; might allow simulation of lead. Nearly unlimited line-of-sight pairing range. High pairing reliability in any atmosphere. Brassboard system is in operation. Should be a low cost approach. | Relatively large effective beam diameter. Difficult to control maximum range. System cannot fit completely inside gun tube |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | System uses 10.6 micron CO2 laser transmitter. Target is a single thermo-electrically cooled HgCdTe detector mounted on top of the vehicle with a conical mirror to give 360 degree coverage | Good obscurant penetration through smoke. Small, controllable beam diameter. Brassboard hardware has been built and tested. | Relatively expensive and complex cooled detectors (especially for multiple detectors). Possible problems achieving adequate range through dust. Single, top-mounted detector location is undesirable (cannot play defilade, unrealistic aiming) |
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| Synrad, Inc.<br>Bothell, Washington | System uses high power CO2 laser to transmit a single pulse for pairing. The target would use single or multiple uncooled pyroelectric detectors. A wide-beam RF (24 GHz) transmitter and receiver would then be used to transmit pairing data. | Uncooled detector relatively inexpensive; possibly adaptable to belt-type systems. Laser transmission is single, high-energy pairing pulse. Good obscurant penetration. Requirement to receive both IR and RF message could minimize false triggering. | Unproven detector capability in operating environment. Requires separate RF system to transmit pairing data. Concept has not been demonstrated. |
| IR (1.54 Micron) TOPS | System uses a 1.54 micron erbium glass laser transmitter. A choice of either lead sulfide or germanium uncooled detectors could be acceptable as target receiver. | Technology proven in existing eyesafe rangefinder. Can penetrate smoke. Uses inexpensive visual optics and uncooled detectors which can be distributed for realistic target geometry. Small, controllable beam diameter. | Obscurant penetration of erbium glass laser radiation may not equal performance of that of 10.6 micron CO2 laser. |

| SYSTEM | MATURITY OF TECHNOLOGY | SAFETY | ABILITY TO PAIR THROUGH OBSCURANTS | REALISM |
|---|---|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | Components are from mature technology. Several vendors should be able to supply acceptable laser and detectors. | Eye safe. The CO2 laser transmitter energy density can be controlled so as to cause no personnel safety problems. | System uses10.6 micron CO2 laser which can penetrate natural obscurants, fog oil smoke, and limited dust. | History indicates that detectors mounted in a single location on top of tank result in unrealistic aiming. Like MILES,system cannot be used with fire control computer |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | Components are from highly developed current technology which provide commercial components for police radar and radar detectors. | Safe. Transmitter uses 24 GHz frequency, a frequency commonly used for radar traffic controllers, which has posed no known safety problems for personnel. | The 24 GHz RF transmission can penetrate natural obscurants, fog oil smoke, and some dust | System could use corner detectors for greater realism. Wide hit window might allow use of fire control computer |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Components are from mature technology. Several vendors should be able to supply acceptable laser and detectors. | Eye safe. The CO2 laser transmitter energy density can be controlled so as to cause no personnel safety problems. | System uses 10.6 micron CO2 laser which can penetrate natural obscurants, fog oil smoke, and limited dust. | History indicates that detectors mounted in a single location on top of tank result in unrealistic aiming. Like MILES, system cannot be used with fire control computer. |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Components are from highly developed current technology which provide commercial components for police radar and radar detectors. | Safe. The system uses three 24 GHz transmitters. See Sierra Nevada's K-TOPS above. | The 24 GHz RF transmission can penetrate natural obscurants, fog oil smoke, and some dust | System could use corner detectors for greater realism. Wide hit window might allow use of fire control computer. |
| Synrad, Inc.<br>Bothell, Washington | Components are from mature technology. Some development efforts for detector circuit may be necessary. | Laser transmitter should be capable of operating within eye safe limits. | System uses10.6 micron CO2 laser which can penetrate fog oil smoke and some dust. | Possibility of using multiple detectors, as with MILES, would permit more realistic gunnery. Like MILES, system cannot be used with fire control computer. |
| IR (1.54 Micron) TOPS | Erbium glass laser transmitter and the choice of either lead sulfide or germanium detectors represent mature technologies. | System would be eyesafe; the transmitter is currently being used in an eyesafe military rangefinder system. | Laser transmitter is reported to have good obscurant penetration (see note 1 in Comments) | |

| SYSTEM | MILES COMPATIBILITY | OPERATING RANGE | ANGULAR COVERAGE | PAIRING DATA |
|---|---|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | The system would complement MILES and can be designed to interface with MILES. | Range will depend on laser energy and coded messages 3 4 km is probable | The system would have a field of-view of 360 degrees in azimuth and -15 to +45 degrees in elevation. | Should be able to transmit adequate pairing data if a laser of sufficient power is used |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | The system would complement MILES and can be designed to interface with MILES. | Reported to have ranging capability from 50 m to 5 km | Coverage is accomplished by four separate RF receiver pairs, each of which provides coverage over a sector of 90 degrees in azimuth and 45 degrees in elevation | Prototype can identify 1024 players, 16 weapon/munition possibilities. |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | The system would complement MILES and can be designed to interface with MILES. | Expected to be up to 5 5 Km in fog oil smoke based on extrapolation of shorter range test data. | The system would have a field of-view coverage of 360 degrees in azimuth and -15 to +45 degrees in elevation. | MILES-type pairing data plus player ID has been developed. |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | The system would complement MILES and can be designed to interface with MILES. | Should be comparable to Sierra Nevada K-TOPS. | The system would have a field-of-view of 360 degrees in azimuth and -15 to +45 degrees in elevation. | Has not been determined but should be acceptable |
| Synrad, Inc.<br>Bothell, Washington | The system would complement MILES and can be designed to interface with MILES. | Range should exceed 3 km since high power CO2 laser is used only to establish pairing between weapon and target. | Proposed concept should meetArmy requirements but has not yet been determined. | Would be transmitted by RF. Has not yet been determined but should be acceptable. |
| IR (1.54 Micron) TOPS | The system would complement MILES and can be designed to interface with MILES. | Not yet determined, but appears acceptable. | Concept should meet Army requirements but has not yet been determined. | Not yet determined, but should be acceptable |

## Matrix Assessment of Obscuration Technologies
(continued)

| SYSTEM | PAIRING DURATION | MULTIPLE PAIRING | POWER REQUIREMENTS | AVAILABILITY |
|---|---|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | Should be acceptable, but will be a design driver | Small beam width should preclude multiple pairing | Would be compatible with combat vehicle power supply | The basic components for this system are readily available. There may be a need for some development work for the detector window configuration to provide wide field of view |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | 250 milliseconds, about the allowable maximum. | Could be a problem due to relatively large expected beam diameter. | Would be compatible with combat vehicle power supply. | The period of construction should be about two years. Prototype systems should be available by the end of CY 1989. |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Should be acceptable, but will be a design driver. | Small beam diameter should preclude multiple pairing. | Would be compatible with combat vehicle power supply. | Prototypes could be available in nine months. |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | RF transmission of pairing data results in very short processing time. | Could be a problem due to relatively large expected beam diameter. | Would be compatible with combat vehicle power supply. | Unknown. |
| Synrad, Inc.<br>Bothell, Washington | RF transmission of pairing data results in very short processing time (less than 10 milliseconds). | Small laser beam diameter should preclude multiple pairing. RF transmitter does not have to be narrow beam. | Would be compatible with combat vehicle power supply. | Should be possible to construct system within two years. Some developmental testing of laser ranging and beam divergence may be necessary. |
| IR (1.54 Micron) TOPS | | Not yet determined, but should be acceptable | Would be compatible with combat vehicle power supply | Could be prototyped within two years. Some developmental testing to define laser range compatibility, beam geometry, and detector performance needs to be completed. |

## Matrix Assessment of Obscuration Technologies
(continued)

| SYSTEM | SYSTEM COST (Per vehicle) | COMMENTS |
|---|---|---|
| IR-TOPS<br>Schwartz Electro-Optics<br>Orlando, Florida | Approximately $10,000. | The receiver-target for this system might present an unrealistic hit zone geometry |
| K-TOPS<br>Sierra Nevada Corporation<br>King City, California | Assuming development is completed, cost will be $7500/system for orders in excess of 5000 units. | Data needed on how a moving target or transmitter affect hit window and reliability of pairing. System has a constant beam divergence. Most developed system so far. System has been smoke tested under laboratory conditions |
| IR-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Less than $10,000 | This system is similar to the Schwartz IR-TOPS. Breadboard hardware has been tested. Considerable analysis done |
| K-TOPS<br>Loral Electro-Optical Systems<br>Pasadena, California | Proposed system would use commercially-available radar components. Approximately $10,000 for production | Further work needs to be done to define beam size and hit window. Very limited development so far. |
| Synrad, Inc.<br>Bothell, Washington | Approximately $10,000. | Further work needs to be done to verify that laser/pyroelectric detector pairing range is acceptable. Needs work on laser beam sharpening to optimize near-miss. Methods of mounting detectors to minimize microphonics and environmental inputs need development. |
| IR (1.54 Micron) TOPS | | This system has not been developed nor proposed by industry. Concept evolved from reported availability of an eyesafe laser rangefinder built by KEI Laser, Inc., Orlando, Florida.<br><br>Note 1. Reported to be capable of penetrating battlefield smokes beyond 4 Km by Mr. Jack Minch, V.P. of KEI Laser, Inc. |

APPENDIX B

## Significant Contacts

1. Government

   a. Art Kendall, Harry Diamond Laboratory, Adelphi, MD.

   b. Howard Smalley, PM-SMOKE.

   c. Spike Kenn, USACDEC, Monterey, CA.
   Bill West, USACDEC, Monterey, CA.

2. Industry

   a. Neil Butler, Honeywell Electro-Optical Div., Lexington, MA.

   b. Paul F. Jacobs, Xerox Electro-Optical Systems, Pasadena, CA.
   A. I Weinstein, Loral Electro-Optical Systems, Pasadena, CA.
   Chris R. Dawson, Loral Electro-Optical Systems, Pasadena,CA.

   c. Tom Kaffenberger, KEI Laser, Inc., Orlando, FL.
   Jack R. Minch, KEI Laser, Inc., Orlando, FL.

   d. Richard J. Wangler, Schwartz Electro-Optics Inc., Orlando, FL.
   Harold W. Grossman, Schwartz Electro-Optic, Inc., Orlando, FL.

   e. George Clary, Sierra Nevada Corporation, King City, CA.
   Jim Dickert, Sierra Nevada Corporation,King City, CA.
   Faith Ozmen, Sierra Nevada Corporation, King City, CA.

   f. Peter Laakmann, Synrad Inc., Bothell, WA.

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2. Paul E. Martinet et al., "Dual Wavelength Laser Study", Report DAAK21-79-C-0027, April 1980.

3. KEI Technical Report, "Eyesafe Hand-Held Laser Rangefinder Model LH-83", September 30, 1984.

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5. Ken Levin, "Several Commercial Applications Spring from Advances in Infrared Fiberoptics", Fiberoptic Product News, August, 1987.

6. Private communication, Ken Levin, Infrared Fiber Systems, Inc.

7. Infrared Fiber Systems, Inc., data sheet, "Chalcogenide Glass Fiber Prices", dated May 21, 1987.

8. Private communication, Howard Smalley, PM-SMOKE.

# APPENDIX F

## ARMY STATEMENT OF WORK
## FOR
## FUTURE GENERATION TACTICAL ENGAGEMENT SYSTEMS

DATE: 10 Sep 85

STATEMENT OF WORK

SUBJECT: Future Generation Tactical Engagement Systems

I. BACKGROUND: The current MILES system is based on technology capabilities and requirements that are approximately ten years old and targets those weapon systems found at the battalion task force level and below. Tactical Engagement Simulations training experience with the current system has revealed many areas for possible system improvements, such as size, durability, cheat-proofing, etc., as well as new requirements, such as gathering data on exercises, automating medical casualty simulation, operations on the obscured battlefield, etc.

II. OBJECTIVE: Initiate a system engineering study effort to identify improvements required by the Army in future MILES procurements, the next generation of MILES-type training devices and the conduct of tactical engagement simulation training. Determine the applicable technology, development and production costs and research and development leadtime required to field the proposed technology improvements within the Army schedules.

III. SCOPE OF STUDY:

A. The study will identify those technological improvements and requirements that can be incorporated into the production of future programs of MILES procurement scheduled for FY86-91 and those that should be incorporated into the next generation MILES type system scheduled for fielding in the mid 1990s. A program implementation plan will be provided to PM TRADE per Para V.

B. The initial product of the study will be the development of a Prioritized Needs Statement (PNS) which defines system improvements and new training requirements and ranks them in terms of user defined priorities.

This is to be developed using the same methodology evolved for the indirect fire and mines effects simulator programs. Results are to be presented to the Future Generation Tactical Engagement Simulation (TES) SAG for final approval. It is suggested as a minimum, coordination be made with USAREUR, FORSCOM, 8th U.S. Army, TRADOC (CAC, and other appropriate TRADOC activities). A plan for accomplishing the PNS development will be provided to PM TRADE. The Army Support Center and PM TRADE will evaluate and staff the proposed plan with the SAG.

C. The determination of the technological improvements and training requirements to be incorporated will be based on the research and development effort required and associated costs, the estimated unit production costs and the leadtime for inclusion in the procurement/production technical data package through the analysis of the current and projected state-of-the-art of each technology. This effort will be developed through the conduct of a systematic three-phase effort:

(1) Trade-Off Determinations

Description:

The relationships among the principal performance measures of the considered systems (example: range and accuracy) and the relationships between the principal performance measures, resource costs, and alternate support concepts, will be determined for the system approaches being considered. This tradeoff information is of critical importance to the rational progressive refinement of the general description of the system to be developed, produced, and supported.

Logistic requirements such as transportability and supportability and operational performance characteristics such as reliability and maintainability are to be considered in establishing design characteristics.

The influence of life cycle support costs, maintenance support alternatives, and feasibility of required calibration support concepts will be considered in these tradeoffs.

(2) Trade-Off Analysis and Evaluation

Description: The Trade-off Determination and PNS is to be provided to PM TRADE for evaluation by ATIC-TS and the Future Generation Tactical Engagement Siumulation (TES) Study Advisory Group (SAG). The results of the evaluation will be provided to PM TRADE by the SAG and then to JPL for documentation. The objective of this evaluation is to determine which of the general technical approaches/alternatives offered in the Trade-Off Determination are best.

(3) Conceptual Best Technical Approach (BTA)

Description: The general BTA identified in the preceding Trade-Off Analysis and Evaluation process will be used as the basis for defining identifying and defining the BTA to be pursued in advanced or full-scale engineering development. This will define the technological and system trade-offs used in defining the conceptual BTA.

D. The development of the PNS and Trade-Off Determinations should as a minimum consider the following:

(1) Increased reliability and maintainability.

(2) Size and weight reduction (transmitters and other components).

(3) Increased ability to resist cheating.

(4) Longer exercise duration expectancy

(5) Operation under obscured battlefield conditions.

(6) Incorporation of tactical engagement simulation functions into a single data processor.

(7) Increased ranging and lead-angle capability.

(8) Increased kill code capacity of system.

(9) Ability to shoot through foliage.

(10) Automatic gathering of data on training exercise.

(11) Method to automate data transfer for use in After-Action Reviews.

(12) Display of the type and severity of wounds.

(13) Increase capability to automatically assess battle damage on vehicles (degraded performance-weapons, mobility, communication).

(14) Compatability/interfaces with current and planned NATO systems, CDEC, TCATA, and the NTC.

(15) Compatability in interfacing with current and new weapons systems to include OPFOR, NBC, Aircraft, etc.

(16) Methods to reduce personnel required for control of exercises.

(17) Capability of being imbedded in future systems.

(18) Providing training transparency to the user.

(19) Improved simulation of HIT signatures.

(20) Increase direct fires capability.

(21) Ability to assess casualities and damage in MOUT.

(22) Improved damage and casualty assessment.

IV. FUTURE WORK (FY87 START)

Upon successful completion of the effort in the SOW, it is anticipated that a development effort will be initiated to reduce the technological and costs risks defined in the conceptual BTA. Proof-of-concept demonstrations and tests may be utilized for validation. JPL will provide PM TRADE a draft SOW and cost estimate for this effort.